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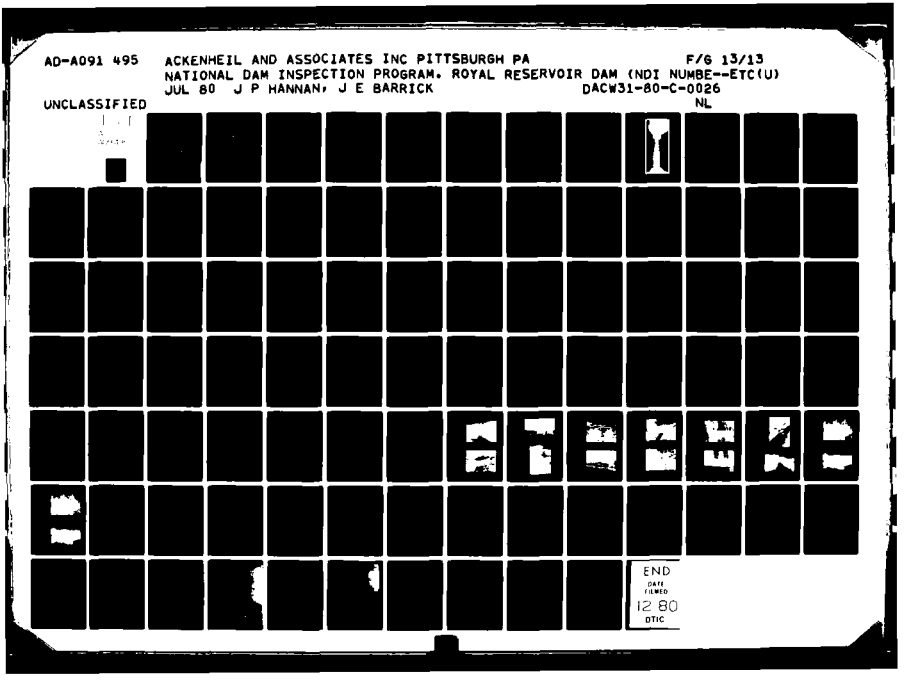

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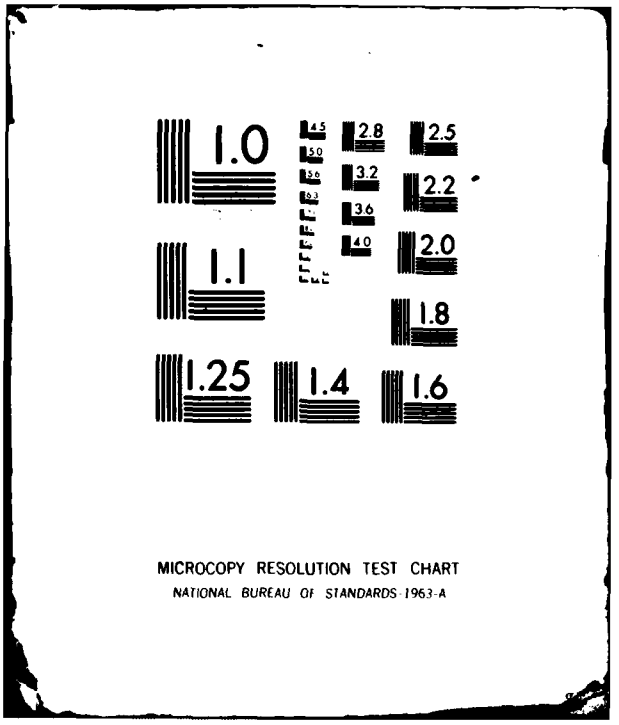
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OHIO RIVER BASIN
ROWES RUN
FAYETTE COUNTY

PENNSYLVANIA

NDI No. PA 00220
PENN DER No. 26-41

ROYAL RESERVOIR DAM

JERRY A. GLOVER AND LEWIS G. ROSS

DACW 31-80-C-0026

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

PREPARED FOR

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
BALTIMORE, MARYLAND 21203

BY

ACKENHEIL & ASSOCIATES GEO SYSTEMS, INC.
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JULY 1980

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National Dam Inspection Program.

OHIO RIVER BASIN

ROYAL RESERVOIR DAM

FAYETTE COUNTY, COMMONWEALTH OF PENNSYLVANIA

NDI Number PA 00220

PennDER Number 26-41

Ohio River Basin,
Rowes Run, Fayette County, Pennsylvania.

PHASE I INSPECTION REPORT,
NATIONAL DAM INSPECTION PROGRAM

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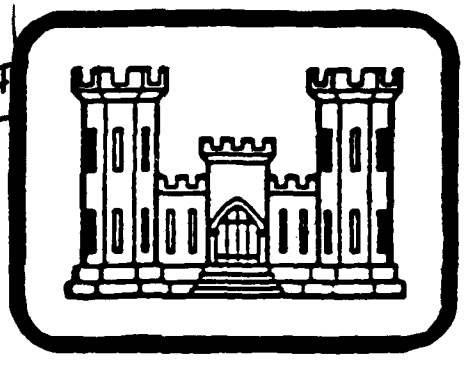

Prepared for: DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

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(15) DACW31-80-C-0026

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Date: July 1980

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I investigations. Copies of these guidelines may be obtained from the Department of the Army, Office of Chief of Engineers, Washington, D.C. 20314.

The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon visual observations and review of available data. Detailed investigations and analyses involving topographic mapping, subsurface investigations, materials testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for such studies which should be performed by the owner.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of the dam depends on numerous and constantly changing internal and external factors which are evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some time in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I investigations are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" (PMF) for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

SYNOPSIS OF ASSESSMENT AND RECOMMENDATIONS

NAME OF DAM:	Royal Reservoir
STATE LOCATION:	Pennsylvania
COUNTY LOCATION:	Fayette
STREAM:	Rowes Run, a tributary of Redstone Creek.
DATES OF INSPECTION:	16 November 1979
COORDINATES:	Lat. 39°58°54", Long. 79°48'30"

ASSESSMENT

Based on a review of available design information and visual observations of conditions as they existed on the date of the field inspection, the general condition of the Royal Resevoir Dam is considered to be poor.

This assessment is based on visual observations and hydrology calculations that indicate:

1. Advanced deterioration and structural instability of the principal and emergency spillways.

2. "Inadequate" discharge capacity of the emergency spillway.

3. A significant discharge of water (from the brick and concrete building) from an unknown and possibly uncontrolled source.

4. Detrimental erosion, drainage and vegetation conditions on and adjacent to the dam.

5. Lack of information concerning location and operability of outlet works facilities.

6. Lack of debris control facilities at the inlet to the principal spillway.

The structure is classified as a "small" size, "significant" hazard dam. Corps of Engineers guidelines recommend a Spillway Design Flood (SDF) of the 100 year storm to 0.5 times the Probable Maximum Flood (PMF) for a "small" size, "significant" hazard dam. Royal Reservoir Dam's Spillway Design Flood is 1/2 the Probable Maximum Flood.

SYNOPSIS OF ASSESSMENT AND RECOMMENDATIONS (CONT'D)
Royal Reservoir Dam

Spillway capacity is "inadequate" because the non-overtopping flood discharge capacity, as estimated using the HEC-1 computer program was found to be twenty one percent of the PMF.

The visual inspection indicated deficiencies which are considered correctable. The deficiencies can be corrected or improved through implementation of the following recommended remedial, monitoring and/or maintenance efforts.

RECOMMENDATIONS

1. Additional Investigations: It is recommended that the owner immediately retain the services of registered professional engineer knowlegeable and experienced in the design and construction of earth dams and concrete spillways to provide an engineering investigation of Royal Reservoir Dam. This investigation should include but not be limited to the following:

(a) Evaluate the stability, hydraulic capacity, and structural integrity of the principal and emergency spillway facilities and make recommendations as required to bring the structures to an acceptable condition.

(b) Investigate the physical condition and operating characteristics of the outlet works facilities and make specific recommendations on improvements, replacement, or abandonment of the various pipelines.

(c) Investigate the source of the significant flow emanating from within the brick and concrete structure at the toe of the embankment. Make recommendations related to elimination, control and/or monitoring of the flow.

2. Emergency Operation and Warning Plan: Concurrent with the additional investigations recommended above, the owner should develop an Emergency Operation and Warning Plan including:

(a) Guidelines for evaluating inflow during periods of heavy precipitation or runoff.

(b) Procedures for around the clock surveillance during periods of heavy precipitation.

(c) Procedures for drawdown of the reservoir under emergency conditions.

(d) Procedures for notifying downstream residents and public officials, in case evacuation of downstream areas is necessary.

3. Remedial Work: The Phase I Inspection of Royal Reservoir Dam also disclosed several deficiencies of lower priority which should be corrected during routine maintenance.

(a) Remove trees and root systems with a diameter greater than 1/2 inch from the embankment and groins. This work should be performed under the direction of a professional engineer, knowledgeable in dam design and construction.

(b) Closely mow the embankment slopes, crest, groins, abutments and immediate adjacent areas. Remove the cuttings from the site.

(c) Locate and backfill completely, all animal burrows, erosional gullies, and depressions on the embankment, groins and adjacent abutment areas.

(d) Contact the responsible road maintenance authority concerning cleanout and repair, if required, of the clogged roadway drainage system on the right abutment.

(e) Develop and implement formal maintenance and inspection procedures.

SYNOPSIS OF ASSESSMENT AND RECOMMENDATIONS (CONT'D)
Royal Reservoir Dam

4. Orderly Breaching: In lieu of performing the above recommendations, the owner should engage the services of a professional engineer, knowledgeable in dam design and performance, to prepare specifications for breaching the structure, to make it incapable of impounding water. The structure should then be breached under the direction of the professional engineer and in accordance with applicable state and local regulations.

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
James Ellsworth Barrick, II
ENGINEER
No. 022639-E

24 July 1980
James P. Hannan Date
Project Engineer

24 July 1980
James E. Barrick, P.E. Date
PA Registration No. 022639-E

Approved by: 21 August 1980
JAMES W. PECK Date
Colonel, Corps of Engineers
District Engineer

ROYAL RESERVOIR DAM

OVERVIEW

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
ROYAL RESERVOIR DAM
NATIONAL I. D. NO. PA 00220
PennDER No. 26-41

SECTION 1
PROJECT INFORMATION

1.1 GENERAL

a. Authority: The Phase I investigation was performed pursuant to authority granted by Public Law 92-367 (National Dam Inspection Act) to the Secretary of the Army through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose: The purpose of the investigation is to make a determination on whether or not the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Dam and Appurtenances:

(1) Embankment: Royal Reservoir dam was designed and constructed as an earthfill structure. The embankment is 400 feet long, (excluding spillway) with a maximum toe to crest height of 32 feet and a crest width of 175 feet. The embankment's upstream slope was observed to be 1.2H:1V above the water line; the downstream slope ranged from 3.8% to 2.9H:1V. A two lane asphalt paved township road crosses the crest of the dam.

(2) Outlet Works: The outlet facilities for Royal Reservoir Dam reportedly include a six inch diameter cast iron water supply pipe and two 16 inch diameter terra cotta "drainlines." No outlet facilities components were inspected during the field reconnaissance, although all outlet pipes were reported to have control valves.

(3) Principal Spillway: The principal spillway consists of two 24 inch diameter terra cotta pipes located beneath the emergency spillway channel. Current freeboard above the pipes' invert elevation is 9.9 feet. The pipes discharge to the spillway chute below the emergency spillway.

(4) Emergency Spillway: The Royal Reservoir Dam emergency spillway is a concrete lined open channel near the left abutment. The spillway flow control is a broad crested weir formed by a two lane asphalt paved township road that crosses the dam's crest.

The discharge channel is a flow converging structure that narrows to 20 feet wide about 75 feet below the road and to 10 feet wide at the downstream toe of the dam.

(5) Freeboard Conditions: Freeboard between the principal spillway inlet invert (normal pool elevation) and the current top of dam is 9.9 feet. Emergency spillway freeboard (between crest elevation and current top of dam) is 3.1 feet.

(6) Downstream Conditions: Rowes Run, in the first 1.5 miles below Royal Reservoir Dam, flows through a broad, partially wooded valley. Two inhabited dwellings lie on the floodplain in this reach.

Further downstream, the valley narrows and steepens as it approaches Redstone Creek, 2.5 miles below the dam. In this reach, several inhabited dwellings are located along the valley wall at elevations well above the creek level.

Two commercial/industrial facilities and several bridges are located on the floodplain between the dam and Redstone Creek.

Within this reach is an abandoned beehive coke plant approximately 1000 feet from the embankments toe.

(6) Reservoir: Royal Reservoir is 1600 feet long at normal pool elevation and has a normal surface area of 8 acres. When the pool elevation is at the crest of the dam, the reservoir is about 2,000 feet long and has a surface area of 22 acres.

(7) Watershed: The watershed contributing to Royal Reservoir is mostly pastureland and woodland. The village of Chestnut Ridge is within the watershed boundaries as well as some local roads and adjacent dwellings.

b. Location: Royal Reservoir Dam is located in Redstone Township, Fayette County, Pennsylvania, approximately 2.5 miles west of Pennsylvania State Route 51 and 1.7 miles north of U.S. Route 40.

c. Size Classification: The dam has a maximum storage capacity of 239 acre-feet and a toe to crest height of 32.1 feet. Based on the Corps of Engineers guidelines, this dam is classified as a "small" size structure.

d. Hazard Classification: Royal Reservoir Dam is classified as a "significant" hazard dam. In the event of a dam failure, commercial development and local roads on the floodplain below the dam would be subjected to substantial damage. Loss of life is possible but not probable.

e. Ownership: Royal Reservoir Dam is owned from the centerline of the road north, including the upstream slope and reservoir by Jerry A. Glover et. ux. of Chestnut Ridge, Pennsylvania. The owner of the dam from the centerline of the road south, including most of the crest, downstream slope and spillway channel is Mr. Lewis G. Ross et. ux. of Chestnut Ridge, Pennsylvania. Correspondence can be addressed to:

Mr. and Mrs. Jerry A. Glover
Box 173
Chestnut Ridge, Pennsylvania 15422
(412) 677-2730

Mr. and Mrs. Lewis G. Ross
Box 143
Chestnut Ridge, Pennsylvania 15422
(412) 677-4562

f. Purpose of Dam: Royal Reservoir Dam was constructed to provide an industrial water supply for the Royal Mine and Coke Works of the W. J. Rainey Company. Currently, it is used for recreation purposes.

g. Design and Construction History: The dam was built in 1907 and 1908 by the W. J. Rainey Company. There are no records available covering the design or construction of this dam. The current principal spillway was added in 1914 and the current emergency spillway was constructed between 1919 and 1920.

h. Normal Operating Procedure: Royal Reservoir Dam was designed to operate as an uncontrolled structure. Under normal operating conditions, the pool level is maintained by the principal spillway. The water supply pipeline or "drainlines" were not located during the field inspection.

1.3 PERTINENT DATA

a. Drainage Area:	1.6 sq. mi.
b. Discharge at Dam Facility:	
Maximum Flood at Dam Facility	Overtopped 22 March 1916 No depths recorded*
Principal (Ungated) Spillway Capacity at Top of Dam	724 cfs
c. Elevation (feet above MSL)**	
Design Top of Dam	1014.0*
Current Top of Dam (low point)	1013.6
Emergency Spillway Invert	1010.5
Principal Spillway Inlet Invert	1003.7
Normal Pool	1003.7
Sediment Pool	1003.7
Principal Spillway Outlet	1000± *
Outlet Works Inlet Inverts	Unknown
Outlet Works Outlet Inverts	Unknown
Base of Spillway Channel Chute	981.5*
d. Reservoir Length	
Length of Maximum Pool	2000 feet
Length of Normal Pool	1600 feet
e. Reservoir Storage	
Current Top of Dam	239 acre-feet
Emergency Spillway Crest	175 acre-feet
Normal Pool	82 acre-feet*
f. Reservoir Surface	
Current Top of Dam	22 acres
Emergency Spillway Crest	20 acres*
Normal Pool	8 acres*
g. Embankment	
Type	Earth*
Length (including spillway)	450 feet
Height	32.1 feet
Crest Width	175 feet

Slopes	
Upstream	1.2H:1V
Downstream	2.9H:1V
Impervious Core	No*
Cutoff Provisions	No*
Grout Curtain	No*

h. Outlet Works (Water Supply)

Type	6 inch cast iron pipe*
Location	Unknown
Intake	Submerged in Reservoir
Upstream Flow Control	Unknown
Conduit Length	Unknown
Gate Valve	Unknown
Anti-Seep Collars	Unknown
Outlet	Unknown

i. Outlet Works (Drainlines)

Type	Two 16 inch Terra Cotta Pipes
Location	Unknown
Intake	Unknown
Upstream Flow Control	Unknown
Conduit Lengths	Unknown
Gate Valves	Unknown
Anti-Seep Collars	Unknown
Outlet	Unknown

j. Principal Spillway

Type	Two 24 inch Terra Cotta Pipes
Location	Beneath Emergency Spillway Channel
Intake	Within Emergency Spillway Approach Channel
Debris Control	None
Conduit Lengths	115 feet
Conduit Slope	3.2%
Flow Controls	None
Anti-Seep Collars	Unknown

k. Emergency Spillway

Type	Concrete Lined Open Channel
Location	Left Center of Dam
Approach Channel Slope	40%
Crest Length	59 feet
Crest Width	30 feet
Discharge Channel Slope	8.5% (Average)

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* Taken or derived from original specifications and/or drawings.
** To get elevations on design drawing, subtract 10 feet.

SECTION 2
ENGINEERING DATA

2.1 DESIGN

The files of the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER) were reviewed but no original engineering data was found.

A report prepared for the Water Supply Commission in 1914 stated that the Royal Reservoir Dam was an earthfill structure, 460 feet long, 28 feet high and impounded a reservoir of 26.7 million gallons. The dam was reported to have been constructed on a shale and clay foundation with an eight foot thick "puddle" blanket on the upstream slope. The upstream slope was said to be 1.5H:1V and the original downstream slope was not indicated.

Original outlet facilities placed beneath the dam included a 6 inch diameter cast iron water supply pipe and two 16 inch diameter terra cotta "drain pipes". All three pipes were reported to have control valves.

2.2 CONSTRUCTION

Royal Dam was constructed by the W.J. Rainey Company of Uniontown, Pennsylvania in 1907 and 1908 as an industrial water supply source for the Royal Mine and Coke Plant, located immediately downstream of the dam.

2.3 MODIFICATIONS

Major modifications were made to Royal Reservoir Dam in 1914 and 1919-1920.

a. 1914: Two 24 inch diameter terra cotta "overflow pipes" were placed through the embankment to provide storm discharge capacity. Freeboard above the pipe inverts was reported to be eight feet.

b. 1919-1920: The 1919-1920 modification consisted of construction of a reinforced concrete, open channel emergency spillway across the left end of the embankment. The installation of an emergency spillway was ordered by the Water and Power Resources Board after the dam was overtopped during the storm of 22 March 1916.

2.4 OPERATION

The dam was designed to operate without a dam tender. The principal and emergency spillways are uncontrolled structures and require only periodic maintenance.

The 6 inch cast iron water supply pipeline and associated controls could not be located for examination and no operation specifications were found.

The 16 inch terra cotta "drain pipes" and controls could not be located for examination and no operation specifications were found.

Royal Dam reservoir was emptied sometime between June 1924 and June 1926 and was maintained in an empty condition until it was refilled for recreational purposes in 1952.

2.5 EVALUATION

a. Availability: Engineering data was provided by PennDER, Bureau of Dams and Waterway Management.

b. Adequacy: The available engineering information, though greatly limited, was supplemented by field inspections and supporting engineering analyses and is considered adequate for the purpose of this Phase I inspection report.

c. Validity: Based on the review of the available information, there appears to be no reason to question the validity of the limited engineering data.

SECTION 3
VISUAL INSPECTION

3.1 FINDINGS

a. General: The visual observations of Royal Reservoir Dam and Franklin Lake were performed on 16 November 1979, and consisted of:

(1) Visual observations of the embankment crest and slopes, groins and abutments;

(2) Visual observations of the principal and emergency spillways including concrete training walls, approach and discharge channels, pipes and headwall.

(3) Visual observations of the embankment's downstream toe area including drainage channels and hydraulic structures, mine portal and surficial conditions including debris and refuse materials.

(4) Visual observations of downstream conditions and evaluation of the downstream hazard potential.

(5) Visual observations of the reservoir shoreline and inlet stream channels.

(6) Transit stadia survey of relative elevations along the embankment crest centerline, spillway, and across the embankment slopes.

The visual observations were made during periods when the reservoir and tailwater were at normal operating levels.

The visual observations checklist, field plan, profiles and sections containing the observations and comments of the field inspection team are contained in Appendix A. Specific observations are illustrated on photographs in Appendix C. Detailed findings of the visual inspection are presented in the following sections.

b. Embankment:

(1) Crest: The embankment crest consists of a two lane asphalt paved township road which approaches from a hillside on the right abutment, traverses the embankment crest, enters the emergency spillway channel

near the left abutment and turns to the right as it passes onto the left abutment. The road drops steadily from the right to the left, reaching a low point near the center of the emergency spillway channel. The road then rises approximately 3 feet to the left abutment.

The condition of the road was observed to be good on the date of inspection. There was no serious cracking or indications of sloughing of roadway subgrades.

(2) Upstream Slope: The upstream slope, outside of the limit of the emergency spillway approach channel, was observed to be quite steep and covered with dense brush and small trees. Some erosion was noted along paths that provided access to the shoreline. The shoreline was also somewhat eroded. No slope protection was observed.

(3) Downstream Slope: The embankment's downstream slope appeared to consist primarily of deposits of coarse coal refuse. The deposits have created a generally broad upper slope which is tree covered and vegetated with dense brush, making access and inspection difficult. The deposition of debris and coal refuse on the slope appears to have been done in a random manner resulting in a lumpy, hummocky surface condition. Consequently, no meaningful determination could be made regarding settlement, sloughing, and bulging of the downstream slope. However, no seeps, springs or ground water conditions were observed anywhere on the embankment.

A diversion ditch, clogged by trees and brush, was observed near the lower end of the broad, flat portion of the crest. The ditch transports surface runoff flows along the crest to the spillway near the left abutment.

The lower, steeper portion of the downstream slope, was also densely covered by trees and brush and had the same general uneven appearance as the upper portion of the slope.

Survey measurements showed that the upper portion of the downstream face had a slope of 3.8 percent while the lower, steeper portion sloped at 2.9H:1V.

c. Groins:

(1) Left: The left groin of the embankment consists of the junction of the spillway discharge channel chute and the left abutment and will be discussed in the section under spillways.

(2) Right: The right groin could not be located because of the indistinct demarcation between embankment and abutment. Two access roads cross the groin area near the right end of the dam. Both roads had suffered minor erosion but gave no evidence of dam related seepage conditions.

(3) Downstream Toe: The groin between the embankment and the downstream toe area contains a brick and concrete structure near the right end of the embankment. The structure was observed to be discharging a significant flow of clear water, estimated at between 1 and 1.5 cfs. The origin of the structure is unknown and appears to have been abandoned by bricking up windows. However, the bricking has been broken out to permit discharge of the flows from inside the structure. It was impossible to determine by visual inspection the source of the water flowing from the building.

The flow has created a channel along the downstream toe of the embankment. The channel traverses refuse deposits and has in places undercut the stream bank. The extent of erosion of channel and banks did not appear to be serious but presented some concern because of the erodible nature of the materials that comprise the stream channel and banks.

Near the left end of the embankment toe, the stream entered a brick drop inlet structure and a subsequent concrete pipe that ultimately discharged through the concrete wall at the lower end of the spillway's discharge channel chute. The drop inlet structure contained debris and sediments but was capable of providing discharge capacity for the observed stream flows.

A six foot deep sinkhole was observed to the left of the drop inlet, immediately above the alignment of the concrete pipe. Close observation of the sink hole indicated an opening into the concrete pipe and some brick was observed in the hole.

d. Abutments:

(1) Left: The left abutment near the crest of the embankment contains the two lane asphalt covered township road that approaches the embankment from the northeast. As it enters the vicinity of the embankment, the road drops steeply to the level of the emergency spillway overflow. In this reach, the roadway is protected by concrete training walls of the emergency spillway.

Below the road, the abutment is generally flat and heavily wooded. An animal burrow was noted at the location shown on the field plan.

An abandoned mine fan house lies on the left abutment at the approximate location shown. The center bay of the fan house was measured to be 11 feet below ground level. Only minor ponding in the bottom of the excavation was observed. This ponding may have been the result of rainfall through the open roof of the structure.

(2) Right: The right abutment also contains the two lane asphalt covered township roadway which approaches the crest of the embankment from the southeast. Below the roadway, the abutment slope is relatively steep and heavily wooded. There was no indication of slope instability of this portion of the abutment. On its approach to the embankment, the township road is relatively steep. Two roadside catch basins were noted just beyond the end of the embankment and close examination indicated they were connected by a concrete pipe. The discharge point for the pipe was at a headwall in the right, upstream groin of the embankment. The headwall was entirely clogged by sand and gravel materials. Consequently, flow to the catch basin at the downstream side of the road had developed a new channel along the road, and sediment deposition was noted approximately at the groin of the abutment and embankment. The condition did not appear to represent a serious threat to the embankment but should be corrected.

e. Outlet Works:

(1) Intake Structure: The apparent intake structure for the dam outlet works was observed in the lake above the emergency spillway channel. The structure was entirely submerged by a few inches of water. There was no surface disturbance in the vicinity of the structure indicating no significant inflow.

(2) Conduit and Discharge: The outlet works conduit and its discharge point were not observed during the inspection. A reported gate valve control on the downstream slope was not found during the inspection.

f. Principal (Ungated) Spillway:

(1) General Configuration: The principal spillway for Royal Reservoir Dam consists of two 24 inch diameter terra cotta pipe conduits that pass beneath the emergency spillway overflow section and discharge to the spillway's discharge channel chute below. On the date of inspection, the reservoir pool level was several inches below the inlet to the pipes. However, the pipes were discharging from the downstream end. Close examination of the pipes from the downstream end indicated a sag in the pipeline near the upper end that contained a ponded water condition. The apparent source of the principal spillway discharge was seepage through pipe joints or cracks.

(2) Approach: The inlet to the two principal spillway conduits is at a reinforced concrete headwall in the emergency spillway slab on the upstream slope of the embankment. On the date of observation, there was no trash rack or trash boom to protect the inlet from clogging by debris. Otherwise, the approach to the inlets was clear and unobstructed.

(3) Discharge Channel: Discharge of the two principal spillway conduits is to the lower portion of the spillway discharge channel chute approximately 100 feet below the township road. The condition of the spillway chute is discussed in the following section.

g. Emergency (Ungated) Spillway:

(1) General Configuration: The emergency spillway for Royal Reservoir Dam consists of a concrete slab with concrete training walls near the left end of the dam. The spillway opening at the overflow crest control section is 59 feet. Below this, the channel walls converge to a narrower channel and continue to converge to an approximate 10 foot width below the toe of the dam.

(2) Approach Channel: The approach channel consists of a concrete slab on the upstream slope of the embankment. The slope of the slab was observed to be 1.2H:1V. The slab contains the concrete headwall for the principal spillway conduits. The slab is between 12 inch thick concrete training walls that extend across the upstream slope and then turn and run along the township road.

The condition of the concrete slab and training walls on the date of inspection was very poor. Considerable cracking, spalling and disintegration of concrete was observed.

A wire rope barracade across the opening of the approach channel had been removed.

(3) Overflow Weir: The flow controlling section of the emergency spillway consists of the asphalt covered two lane township road that passes through the emergency spillway. The road was in generally good condition on the date of inspection.

(4) Discharge Channel: The emergency spillway discharge channel consists of a concrete slab with concrete training walls that converge from the 59 foot width of the emergency spillway overflow crest to a 20 foot width, approximately 100 feet below the road. At this point, the channel drops sharply and the principal spillway conduits discharge to the lower spillway chute. The lower section consists of concrete walls that converge gradually to a 10 foot wide section near the toe of the embankment. At this point, the spillway training walls are approximately 12 feet high, and turn at 45° to the left where the downstream channel, Rowes Run, begins.

Discharge channel slopes were observed to be generally steep, being 8.5 percent in the upper reach and 10.7 percent in the lower reach (below the principal spillway outlet).

The condition of the discharge channel was observed to be very poor. Considerable trees and vegetal growth exist in the upper reach of the spillway, creating a very high friction condition for emergency spillway flows.

The right wall of the lower portion of the chute has collapsed onto the spillway base slab. As a result, the soil bank and adjacent trees and vegetal growth are collapsing into the spillway. Near the principal spillway outlet, a large tree has fallen into the discharge channel creating an obstruction to high flows in the channel.

The condition of the concrete is very poor. Considerable cracking, spalling and deterioration of slabs, walls and joints was observed. In particular, the slab was observed to have been eroded at construction joints and underlying gravel and base materials were visible. The junction of the left training wall and base slab was badly eroded and the wall is somewhat undercut. The erosion appears to be the result of continuing discharges from the principal spillway conduits. Because of the flow in the channel on the date of inspection, it could not be determined if seepage is occurring through the lower portions of the training wall and slab.

At the lower end of the discharge channel, where the training walls turn, water is ponded to a depth of 2 to 3 feet in and below the vicinity of the inlet for the previously mentioned concrete drain pipe from the embankment downstream toe area.

h. Instrumentation: No instrumentation was observed during the inspection.

i. Downstream Conditions:

(1) Toe Area: Considerable deposits of coarse coal refuse exist in the area immediately below the downstream toe of the embankment. The configuration of the deposits is such that a small valley exists just beyond the downstream toe that contains the stream channel carrying the discharge from the brick and concrete building on the right. Near the center of the embankment, in the opposing refuse slope, and facing the downstream embankment slope, there is a mine portal that is unblocked for the first 20 to 25 feet. Observation from the opening indicated the portal to be dry. Beyond (downstream) the portal, there is a deposit of domestic debris and refuse including tires, stoves, etc.

(2) Downstream Channel: The Rowes Run channel immediately below the discharge channel outlet is relatively straight but has steep banks covered with considerable tree and vegetal growth. The general hydraulic condition of the channel is poor. The channel is clogged with trees and debris which would obstruct high flows from the spillway chute.

(3) Floodplain Development: Visual inspection indicated that two inhabited dwellings lie on the Rowes Run floodplain below the dam. However, the dwellings appeared to be sufficiently high on the valley wall so as not to be significantly imperiled by a failure of Royal Reservoir Dam. Also, there are two commercial-industrial facilities and several bridges on the Rowes Run floodplain between Royal Reservoir Dam and Redstone Creek, 2.5 miles below.

j. Reservoir:

(1) Shoreline: The reservoir shoreline ranges from flat to steep. The steepest slopes occur on the left side of the reservoir and are generally heavily wooded through the entire reach to the upper end of the reservoir. On the right, the slopes vary from flat near the embankment to moderate near the upstream end. The right reservoir shoreline is generally lightly to moderately wooded and contains considerable spring activity.

In general, no serious sloughing or instability of either shoreline was observed although there was some surface erosion apparently due to surface runoff.

(2) Isthmus: A low, narrow isthmus of land crosses the reservoir at approximately the midpoint of Franklin Lake. The isthmus ranges from 2 to 4 feet high and has two open channel inlets to the lower portion of the reservoir. Consequently, the pool levels in the two ponds are the same.

(3) Inlet Streams: Two streams enter Royal Reservoir near the upstream end. One stream enters from the southwest through a narrow, flat bottomed valley, that appeared to be pasture land. The creek is winding on its approach and contains some trees and vegetation on its bank. At the reservoir, there appears to have been deltaic development which now has trees and brush growing.

The second stream enters the reservoir from the southeast, again through a narrow, flat bottomed valley. This stream is considerably more obstructed by trees and brush than the other. As with the right stream, there is deltaic development at the inlet. This stream also gave some indication of more recent sedimentation but the problem did not appear to be serious.

(4) Watershed: The watershed tributary to Royal Reservoir was observed to be generally as indicated by the U.S.G.S. topographic map. The watershed consists primarily of farmland, pasture, and wood land. No major new construction or mining developments were noted on the date of inspection.

3.2 EVALUATION

a. Embankment: The condition of the Royal Reservoir Dam embankment is considered to be poor. This is based on the observed steep and partially eroded upstream slope, the non-uniform surface of the downstream slope, the existence of erodable materials on the downstream slope, the existence of detrimental surface drainage flows from the right abutment, and a general lack of maintenance of the structure.

b. Outlet Works: The condition of the outlet works could not be evaluated, except that the facility did not appear to be operative on the date of inspection. The failure to locate and observe the operation of flow controls and outlet conditions is considered to be a deficiency.

No indication was found that an upstream flow control mechanism exists for the outlet works. This is considered to be a deficiency.

c. Principal Spillway: The principal spillway for Royal Reservoir Dam is considered to be in poor condition. This is based on the observed lack of a trash rack or trash boom to control clogging of the inlet.

Also, the vertical alignment of the discharge conduits contains a sag beneath the roadway, creating a ponded water condition within the principal spillway conduits. Discharge was observed from the downstream end of the discharge conduits, even though the lake pool level was one-half foot below the invert at the inlet end. This condition is considered to be a deficiency.

d. Emergency Spillway: The emergency spillway including the spillway chute, was observed to be in generally deteriorated condition on the date of inspection. In particular, the growth of trees and dense brush on the spillway slab just below the road creates a high flow resistance condition that may adversely affect the operation of the emergency spillway.

The lower portion of the discharge channel is seriously deteriorated to the extent that the right training wall has collapsed and erosion of the lower portion of the embankment has begun. The condition presents a potential for significant erosion of the downstream portion of the embankment.

Concrete deterioration is also significant in this reach, with erosion through the slab joints revealing subgrade materials below.

The overall general condition of the emergency spillway and chute is considered to be very poor.

e. Downstream Conditions: Lack of knowledge related to the observed significant discharge of water from the brick and concrete building at the downstream toe of the embankment is considered to be a serious deficiency.

Downstream drainage conditions, including the stream channel at the toe of the embankment and the drop inlet and the conduit, should be investigated and improved to provide a measure of safety against erosion of the downstream toe of the embankment.

f. Hazard Potential: Based on the observed conditions below Royal Reservoir Dam, the structure has a "significant" hazard potential.

SECTION 4
OPERATIONAL FEATURES

4.1 PROCEDURE

The reservoir pool level is normally maintained by the invert elevation of the principal spillway conduits.

The outlet works pipelines and their controls were not observed during the field inspection and their operating procedure is unknown.

Normal operation does not require a dam tender.

4.2 MAINTENANCE OF DAM

No planned maintenance schedule is on record. Observations indicate that maintenance procedures are poor.

4.3 INSPECTION OF DAM

The owners are required by the State of Pennsylvania to inspect the dam annually and make needed repairs.

4.4 WARNING SYSTEM

There is no known warning system or formal emergency procedure to alert and evacuate downstream residents upon threat of a dam failure.

4.5 EVALUATION

The current dam maintenance program is considered to be inadequate.

The failure to locate and inability to observe the operability of outlet works pipeline controls is considered to be a deficiency.

The lack of a downstream flood warning plan is considered to be a deficiency.

The recommendations presented in Section 7 should be implemented as part of a general maintenance and surveillance program at the dam.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

a. Design Data: The Royal Reservoir Dam has a watershed of 1,024 acres which is vegetated primarily by woodland and pasture. The watershed is about one and one-half miles long and one-half mile wide and has a maximum elevation of 1,250 feet (MSL). At normal pool the dam impounds a reservoir with a surface area of 8 acres and a storage volume of 82 acre-feet. Normal pool level is maintained at Elev. 1003.7 by the principal spillway conduits.

Spillway capacity and embankment freeboard were made sufficient to accommodate 800 cubic feet per second plus one foot of freeboard, which was considered sufficient for this structure and watershed in 1916. No additional hydrologic calculations were found relating reservoir/ spillway performance to the Probable Maximum Flood or fractions thereof.

b. Experience Data: Records are not kept of reservoir level or rainfall amounts.

There is a recorded overtopping of the dam crest on 22 March 1916, but the depth of overtopping was not reported. At the time, the spillway consisted of two 24 inch diameter pipes with inverts 8 feet below the crest of the dam. As a consequence of this overtopping, the Water Supply Commission of Pennsylvania ordered construction of the emergency spillway which was added in 1919-1920.

The storm of 3 August 1935 raised the reservoir level to within seven feet of the crest. Prior to the storm, the "blow off" pipeline was open and the impoundment was empty.

c. Visual Observations: On the date of the field reconnaissance, a dense growth of small trees and brush was observed in the emergency spillway channel in the reach just below the overflow crest (township road). The location and denseness of this growth could adversely affect emergency spillway discharge capacity to the extent that the embankment might be unnecessarily overtopped by large storm flows.

The inlets to the principal spillway pipes were unprotected from clogging by trash and debris. Though the inlets were clear on the inspection date, subsequent blockage could result in a rise in pool level and consequent loss of storm storage capacity in the reservoir.

Structural deterioration of the discharge channel chute, particularly the collapse of the chute's right training wall, could result in significant embankment erosion and possible failure of embankment and spillway during extended spillway discharge conditions.

d. Overtopping Potential: Overtopping potential was investigated through the development of the Probable Maximum Flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway. The Corps of Engineers guidelines recommend the 100 year storm to 0.5 times the Probable Maximum Flood (PMF) for "small" size, "significant" hazard dams. Based on observed downstream conditions, Royal Reservoir Dam has a Spillway Design Flood (SDF) of 0.5 PMF.

Hydrometeorological Report No. 33 indicates the adjusted 24 hour Probable Maximum Precipitation (PMP) for the subject site is 19.4 inches. No calculations are available to indicate whether the reservoir and spillway are sized to pass a flood corresponding to one half of the runoff from 19.4 inches of rainfall in 24 hours. Consequently, an evaluation of the reservoir/spillway system was performed to determine whether the dam's spillway capacity is adequate under current Corps of Engineers guidelines.

The Corps of Engineers, Baltimore District, has directed that the HEC-1 Dam Safety Version computer program be utilized. The program was prepared by the Hydrologic Engineering Center (HEC), U.S. Army Corps of Engineers, Davis, California. The major methodologies and key input data for this program are discused briefly in Appendix D.

The peak inflow to Royal Reservoir Dam was determined by HEC-1 to be 4,040 cfs for a full PMF. The peak inflow for the SDF was determined to be 2,020 cfs.

An initial pool elevation of 1003.7 was assumed prior to commencement of the storm.

According to the HEC-1 analysis, at 0.50 PMF, Royal Reservoir Dam is overtopped by a maximum of 1.54 feet of water for a duration of 5 hours and 45 minutes. The analysis is included in Appendix D.

e. Spillway Adequacy: The capacity of the combined reservoir and spillway system was determined by HEC-1 to be 0.21 PMF. According to Corps of Engineers' guidelines, Royal Reservoir Dam spillway is "inadequate."

SECTION 6
STRUCTURAL STABILITY

6.1 AVAILABLE INFORMATION

a. Design and Construction Data: All available design documentation, calculations and other data received from the Pennsylvania Department of Environmental Resources were reviewed. This data is discussed in Section 2 and a detailed listing is included in Appendix B. Selected items are presented in Appendix E.

b. Operating Records: There are no written operating records or procedures for this dam.

c. Visual Observations:

(1) Embankment: The Royal Reservoir Dam embankment was observed to have a generally irregular surface, consisting largely of coal refuse materials downstream and an asphalt paved highway upstream.

The field inspection revealed no significant indications of a high groundwater level in the embankment or evidence of general detrimental embankment stability conditions. Local instability was observed in the vicinity of the spillway's collapsed right training wall where locally steep slopes were sloughing onto the collapsed wall.

(2) Abutments: The abutments of the dam are generally flat and give no indication of instability.

(3) Spillway Chute: The reinforced concrete spillway chute was observed to be seriously deteriorated and partially collapsed. Cracking, tilting, displacement and disintegration of structure components were observed.

d. Performance: Seven inspection reports by state personnel gave no indication of either embankment or spillway structural stability problems over the 73 year history of the dam.

The embankment was overtopped by an unknown depth during the storm of 22 March 1916 but did not fail. This was attributed to the very broad, flat crest and downstream slope.

6.2 EVALUATION

a. Design Documents: The design documentation was, by itself, considered inadequate to evaluate the structure. There were no stability calculations for the embankment or for appurtenant structures.

b. Embankment: Based on visual observations of the embankment's slopes and materials and considering its performance and history, there appears to be no reason to question the stability of the embankment.

c. Principal Spillway: Based on visual observations, the structural stability of the concrete spillway chute is questionable. Additional investigations should be performed.

d. Seismic Stability: According to the Seismic Risk Map of the United States, Royal Reservoir Dam is located in Zone 1 where damage due to earthquakes would most likely be minor.

A dam located in Seismic Zone 1 may be assumed to present no hazard from an earthquake provided static stability conditions are satisfactory and conventional safety margins exist. No calculations were developed to verify this assessment, however.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS

7.1 ASSESSMENT

a. Evaluation:

(1) Embankment: Royal Reservoir Dam's embankment is considered to be in poor condiiton. This is based on visual obsevations of steep, eroded upstream slope conditions, irregular downstream slope conditions, detrimental surface drainage conditions, obscuring vegetation including dense brush and trees, and a general lack of maintenance.

(2) Outlet Works: The outlet works facilities could not be evaluated because they could not be located during the field reconnaissance.

(3) Principal Spillway: The condition of the principal spillway is considered to be poor. This is based on observed pipe alignment irregularities, leakage conditions, and lack of debris control structures at the inlet.

(4) Emergency Spillway and Chute: The emergency spillway channel and spillway chute are considered to be in poor condition both structurally and hydraulically. This is based on observed detrimental vegetal growth, serious structural deficiencies, and general concrete deterioration.

(5) Flood Discharge Capacity: The emgergency spillway flood discharge capacity is "inadequate" based on current Corps of Engineers guidelines. This is based on hydrologic/hydraulic computations using the HEC-1 Dam Safety Version computer program, that indicated the existing reservoir/spillway system is capable of passing 0.21 PMF. At 0.5 PMF, the embankment is overtopped by a maximum 1.54 feet for a total of 5 hours and 45 minutes.

(6) Downstream Conditions: Based on the results of the visual observations and the hydrologic/ hydraulic computations, the lack of an emergency warning and operation plan is considered to be a deficiency.

b. Adequacy of Information: The available information and the observations made during field inspections of the dam are considered sufficient for purposes of the Phase I inspection report.

c. Urgency: The recommendations presented in Sections 7.2a and 7.2b should be implemented immediately.

d. Necessity for Additional Data/Evaluation: Additional engineering information is required to adequately evaluate and improve the structural stability and hydraulic capacity of the facilities.

7.2 RECOMMENDATIONS

a. Additional Investigations: It is recommended that the owner immediately retain the services of registered professional engineer knowledgeable and experienced in the design and construction of earth dams and concrete spillways to provide an engineering investigation of Royal Reservoir Dam. This investigation should include but not be limited to the following:

(1) Evaluate the stability, hydraulic capacity, and structural integrity of the principal and emergency spillway facilities and make recommendations as required to bring the structures to an acceptable condition.

(2) Investigate the physical condition and operating characteristics of the outlet works facilities and make specific recommendations on improvements, replacement, or abandonment of the various pipelines.

(3) Investigate the source of the significant flow eminating from within the brick and concrete structure at the toe of the embankment. Make recommendations related to elimination, control and/or monitoring of the flow.

b. Emergency Operation and Warning Plan: Concurrent with the additional investigations recommended above, the owner should develop an Emergency Operation and Warning Plan including:

(1) Guidelines for evaluating inflow during periods of heavy precipitation or runoff.

(2) Procedures for around the clock surveillance during periods of heavy precipitation or runoff.

(3) Procedures for drawdown of the reservoir under emergency conditions.

(4) Procedures for notifying downstream residents and public officials, in case evacuation of downstream areas is necessary.

c. Remedial Work: The Phase I Inspection of Royal Reservoir Dam also disclosed several deficiencies of lower priority which should be corrected during routine maintenance.

(1) Remove trees and root systems with a diameter greater than 1/2 inch from the embankment and groins. This work should be performed under the direction of a professional engineer, knowledgeable in dam design and construction.

(2) Closely mow the embankment slopes, crest, groins, abutments and immediate adjacent areas. Remove the cuttings from the site.

(3) Locate and backfill completely, all animal burrows, erosional gullies, and depressions on the embankment, groins and adjacent abutment areas.

(4) Contact the responsible road maintenance authority concerning cleanout and repair, if required, of the clogged roadway drainage system on the right abutment.

(5) Develop and implement formal maintenance and inspection procedures.

d. Orderly Breaching: In lieu of performing the above recommendations, the owner should engage the services of a professional engineer, knowledgeable in dam design and performance, to prepare specifications for breaching the structure, to make it incapable of impounding water. The structure should then be breached under the direction of the professional engineer and in accordance with applicable state and local regulations.

APPENDIX A

VISUAL INSPECTION CHECKLIST

VISUAL OBSERVATIONS CHECKLIST I
(NON-MASONRY IMPOUNDING STRUCTURE)

Name Dam Royal Reservoir County Fayette State Pennsylvania National ID # PA 00220

Type of Dam Earth Hazard Category Significant

Date (s) Inspection 16 November 1979 Weather Partly cloudy, cool Temperature 40°F

Pool Elevation at Time of Inspection 1003 ± (MSL)
Tailwater at Time of Inspection Unknown

Inspection Personnel:

J. E. Barrick, P.E.	Ackenheil & Associates, Hydrologist and Project Manager.
J. P. Hannan	Ackenheil & Associates, Geotechnical Engineer
S. G. Mazzella	Ackenheil & Associates, Civil Engineer
J. B. Zeppieri	Ackenheil & Associates, Geologist
L. G. Ross	Owner

Recorder J. E. Barrick

GEO Project G79153-K
PennDER I.D. No. 26-41

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed, except for diversion ditch that exists along the downstream crest of the embankment paralleling the embankment crest centerline. The ditch runs the length of the embankment crest and originates in the vicinity of the brick and concrete building at the toe of the embankment near the right abutment.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	No apparent cracking or moving was observed at or beyond the toe of the embankment. However, the general vicinity of the downstream slope of the embankment is covered with old deposits of coarse coal refuse, coal fines, coal refuse fines. The material is generally very loose and erodible. The downstream slope of the embankment has a very rough appearing surface. The crest, which is very wide, is quite lumpy in spots. The downstream floodplain is lumpy and hummicky resulting mostly from deposition of piles of refuse and debris. Approximately 50 feet below the apparent toe of the embankment and to the right of center of the embankment, there is a refuse pile comprised of domestic debris, tires, wheels, etc.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	In general, erosion does not appear to be a significant problem at this structure. However, an erosional cavity is apparent immediately behind the brick and concrete structure near the right abutment. This erosion was apparently caused by surface water running across the embankment crest and down the slope impinging upon the building, removing material from the back wall of the structure. This structure is also discharging a large flow of water of unknown origin. This flow travels approximately parallel to the embankment crest centerline along the toe of the embankment slope. The apparent flow is 1 to 1.5 cfs.	

EMBANKMENT (CONTINUED)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES (CONT'D)	The channel containing this flow lies in a depression in the previously mentioned hummicky area below the embankment toe. Erosion has ocurred and is now occurring in the loose refuse deposits in the vicinity. The channel bank is undercut. By standing close to the channel, one risks collapsing the bank. Minor erosion is occurring on the upstream slope of the embankment primarily because of the very steep slope.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	The impounding embankment has a broad crest. The upstream portion of the crest contains a two lane, asphalt paved highway. The highway approaches the crest from a hillside on the right abutment, drops gradually until it approaches the left portion of the embankment where it dips steeply into the emergency spillway. The roadway then rises and proceeds onto the west abutment where it makes a sharp right turn before proceeding into the village of Chestnut Ridge. The highway alignment appears regular both vertically and horizontally. No distress cracks were noted in the highway outside of normal cracking in the asphalt. The remainder of the embankment crest lies downstream of the highway and consists of a relatively broad but uneven area that contains diversion ditches, deposits of coal refuse, and other debris. The crest is wooded, heavily brush covered and difficult to examine.	

EMBANKMENT (CONTINUED)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
RIPRAP FAILURES	No riprap observed.	
SETTLEMENT	Because of the dense growth on the embankment and abutment slopes and because of the uneven distribution of refuse deposits and debris on the slope and abutments, evidence of settlement was not apparent. No settlement was apparent in the embankment crest area containing the township road.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	The locations of embankment groins on the downstream slope on both sides of the embankment were difficult to determine. General observations of these areas indicated no significant seepage or erosional problems. The major apparent source of seepage appears to discharge from inside the brick and concrete building near the toe of the downstream slope, in the vicinity of the right abutment. The structure is appoximately 7 feet high, has a concrete slab roof and, is in a generally deteriorated condition. Windows have been bricked shut and then broken out to permit discharge of flows. The flow discharging from the structure was estimated to be approximately 1 to 1-1/2 cfs. The structure is approximately 16 feet by 34 feet in plan with the long dimension parallel to the embankment crest centerline. The structure is overgrown with brush and trees and is surrounded by deposits of refuse to the extent that access to the roof of the structure from the upstream side is quite easy. An abandoned mine portal exists in the valley immediately downstream of the toe of the structure at approximately the mid-point of the structure. The portal lies approximately 50 feet from the toe and faces the embankment. The structure (as observed from the entrance) appears to be dry.	

EMBANKMENT (CONTINUED)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM (CONT'D)	The discharge from the reinforced concrete building travels approximately parallel to the embankment, through a ravine at the toe of the embankment. The materials that comprise the ravine and sides are generally coal refuse and coal fines. They are quite loose and relatively easily eroded. The creek has undercut the creek bank in places. Toward the left abutment, approximately 40 feet right of the spillway, the creek drops into a brick drop structure and enters a reinforced concrete pipe which parallels the embankment toe. The pipe discharges into the lower end of the spillway discharge channel. Access and measurement of the pipe was impossible but it appears to be either 36 inch or 42 inch I.D. A sinkhole exists along the alignment of the pipe and appears to be the result of surface flows entering the pipe through a broken joint. Brick was visible in the hole. The sinkhole is approximately 8 feet across, 6 feet deep.	
STAFF GAGE AND RECORDER	None observed.	
DRAINS	Other than surface drainage channels, none observed.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUITS	Not observed.	
INTAKE STRUCTURE	Observed in reservoir. Close examination not possible, but no water surface disturbance observed in vicinity of intake.	
OUTLET STRUCTURE	Not observed.	
OUTLET CHANNEL	Unknown	
EMERGENCY GATE	Reported to be on downstream slope by Mr. Ross but not found.	

PRINCIPAL (UNGATED) SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
GENERAL CONFIGURATION	The principal spillway consists of two - 25 inch inside diameter terra cotta pipes located beneath the reinforced concrete emergency spillway overflow section near the left abutment. The two pipes maintain the level of the reservoir approximately seven feet below the crest of the overflow section. The pipes discharge to the concrete lined spillway discharge channel about 90 feet below the township road.	
APPROACH CHANNEL	The approach channel to the pipes was unobstructed on the inspection date. However, there was no trash rack or boom to prevent clogging of the pipe inlets. A cable barricade across the approach channel opening has been removed.	
DISCHARGE CHANNEL	The pipes discharge to the concrete lined discharge channel chute below the township road. The condition of the channel is poor, and is discussed in detail below.	

EMERGENCY (UNGATED) SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	The emergency spillway sill or overflow crest consists of the previously mentioned asphalt surfaced, township road.	
APPROACH CHANNEL	The approach consists of a concrete slab on approximately a 45° slope which rises from the reservoir's normal pool elevation to the roadway. A concrete headwall surrounds the inlet to the two terra cotta pipes (principal spillway). The condition of all concrete in the approach channel is poor. It is badly cracked, spalled and deteriorating. Grass and weeds are growing through a number of the cracks in the approach channel slope. Training walls at both ends are badly deteriorated, cracked, and spalled. The approach channel training walls are 12 inch reinforced concrete.	
DISCHARGE CHANNEL	The discharge channel consists of a concrete slab with reinforced concrete training walls converging from a width of 59 feet at the asphalt township road to 20 feet, 90 feet below the center of the road. At this point, the two terra cotta pipes discharge to the reinforced concrete chute channel. The general condition of the spillway slab and training walls below the roadway is very poor. Trees are growing in the spillway, out of the training walls, and there is significant cracking, spalling and erosion of all concrete surfaces. The outlet channel below the end of the transition is a reinforced concrete slab with reinforced concrete training walls. The walls are approximately 8 feet high. The right wall has collapsed into the spillway channel.	

EMERGENCY (UNGATED) SPILLWAY (CONTINUED)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
DISCHARGE CHANNEL (CONT'D)	Overhanging trees are sloughing onto the collapsed wall. Immediately below the discharge point for the two terra cotta pipes, a large tree has fallen into the spillway and generally obstructs flow. The concrete slab that comprises the base of the spillway is badly eroded at joints. Underlying gravel and base material are visible through the cracks. General cracking patterns indicate complex stress patterns beneath the spillway. Holes have been broken through both the standing and collapsed spillway walls to permit drainage of areas outside of the spillway. The standing wall is generally undercut at the junction with the slab although it does not appear that seepage enters the spillway at this point. Water flowing in the junction is primarily discharged from the terra cotta pipes. Near the end of the spillway structure, the slab drops rapidly and narrows to approximately 10 feet. The wall heights at this point are approximately 12 feet. Here also, the spillway channel turns 45° to the left. In the bend, the previously mentioned 36 or 42 inch concrete pipe discharges at the base of the spillway training wall. Immediately below the bend of the spillway, the channel discharges to the original creek channel.	
BRIDGE AND PIERS	None observed.	
GATE AND OPERATION EQUIPMENT	None observed.	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None observed.	
OBSERVATION WELLS	None observed.	
WEIRS	None observed.	
PIEZOMETERS	None observed.	
OTHER		

DOWNSTREAM CONDITIONS

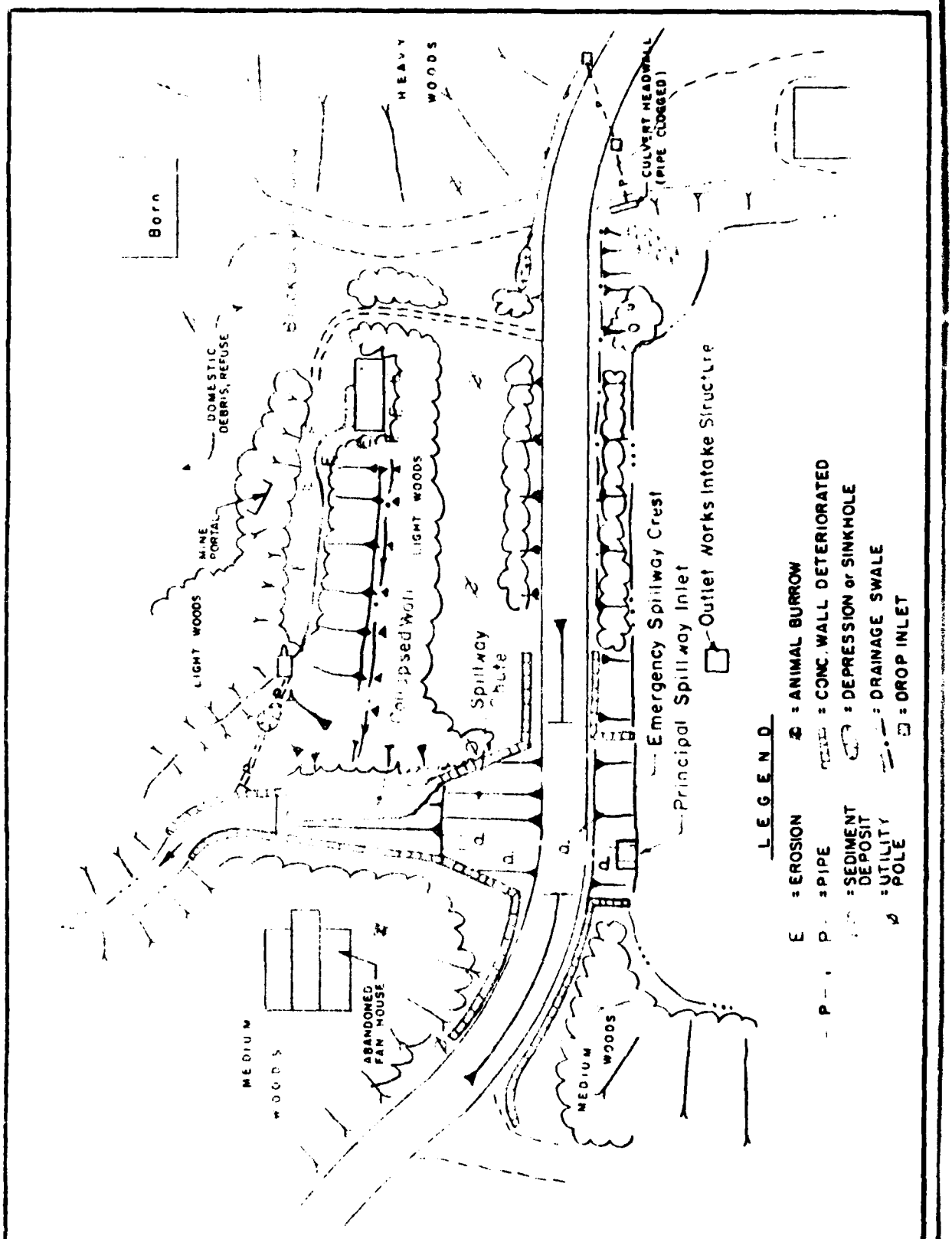
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The discharge channel below the concrete spillway is littered with debris and has very steep slopes which appear in general to be coal refuse and coal fines. Downtimber is visible in several places, erosion of the channel walls is occurring. Evidence of old walls exists at various points in the channel. Channel alignment for the first 100 feet is relatively straight.	
STRUCTURES	On the left abutment, to the left of the spillway chute, there is an abandoned mine fan house. The center bay that contained the fan is eleven feet deep and had only minor water ponding at the bottom on the date of inspection. Near the center of the embankment, beyond the downstream toe, there is a mine portal that was observed (from the entrance) to be dry. Near the right end of the embankment toe, lies the brick and concrete structure previously described under "Junction of Embankment . . . ." Below the dam on the right abutment is a large barn or abandoned commercial building.	
APPROXIMATE NO. OF HOMES AND POPULATION	Visual observation revealed two inhabited dwellings on the Rowe's Run floodplain but heights above stream channel appeared sufficient to preclude serious flooding in event of dam failure. Also, two industrial/commercial facilities may be damaged by flood flows.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONFIGURATIONS	Franklin Lake, which is formed by Royal Reservoir Dam is divided into two parts, upper and lower, by a narrow isthmus near the center of the reservoir. The isthmus other is very low, two to four feet high, and has two lake level outlets, both open channels, that result in equal pool elevations.	
SLOPES	On the left, Royal Reservoir slopes are moderate to steep and are heavily wooded. At the upper left end of the reservoir, an inlet stream enters through a narrow but flat bottomed valley which appeared to be pastureland. On the right, the slope is flat in the reach just above the dam, but increases to moderate further upstream. The slope is lightly to moderately wooded and contains considerable spring activity. Several small ponds have been constructed along and immediately above the reservoir. No significant sloughing or instability of either shoreline was noted although some erosion due to surface runoff was observed.	
SEDIMENTATION	The upper end of the reservoir is generally sedimented, exhibiting a significant deltaic development, containing trees and other vegetal growth. Some recent silting was observed at the inlet of the right stream.	

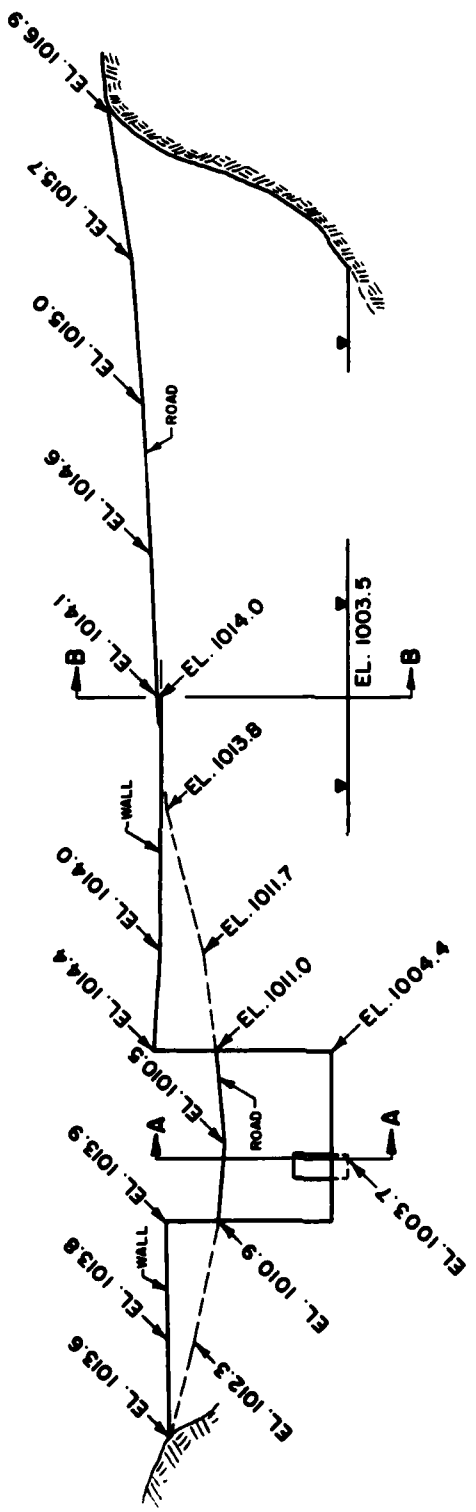
RESERVOIR (CONTINUED)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
INLET STREAMS	Two streams, both entering at the upper end, fed Royal Reservoir. One stream enters from the southwest (previously mentioned) and the other enters from the southeast. Both streams have winding, tree and brush lined channels. The right stream (southeast) is considerably more obstructed than the left.	
WATERSHED	The watershed was observed to be as indicated on the U.S.G.S. topographic map. The watershed is primarily farmsted, pasture and woodland. No major new construction or mining activities were observed.	



DATE: JULY 1980	ROYAL RESERVOIR DAM NATIONAL DAM INSPECTION PROGRAM	FIELD PLAN
SCALE: NONE		
DR: JF CK: JEB	A. C. ACKENHEIL & ASSOCIATES, INC. CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.	

PB

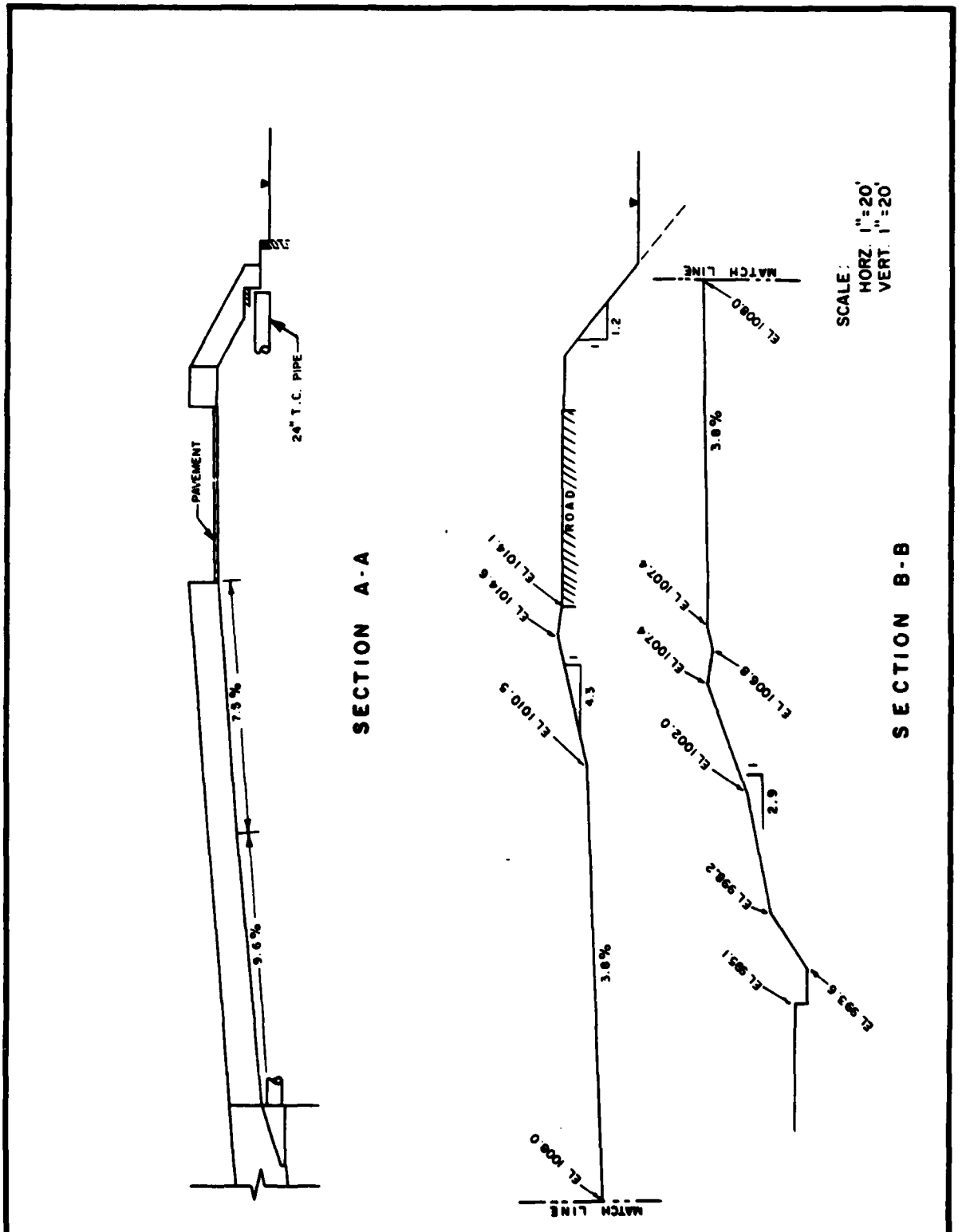


DAM PROFILE
(LOOKING DOWNSTREAM)

SCALE :
HORZ. 1" = 60'
VERT. 1" = 10'

DATE: JULY 1980		ROYAL RESERVOIR DAM NATIONAL DAM INSPECTION PROGRAM	FIELD PROFILE
SCALE: AS SHOWN			
DR: JF	CK: J E B	A. C. ACKENHEIL & ASSOCIATES, INC. CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.	

PR



DATE: JULY 1980	ROYAL RESERVOIR DAM NATIONAL DAM INSPECTION PROGRAM	FIELD SECTIONS
SCALE: AS SHOWN		
DR: JF CK: JEB	A. C. ACKENHEIL & ASSOCIATES, INC. CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.	

APPENDIX B

ENGINEERING DATA CHECKLIST

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Royal Reservoir
I.D. No. PA 00220

ITEM	REMARKS
*Design Drawings	"Proposed Spillway for Royal Reservoir", Royal Works, W. J. Rainey, Uniontown, dated 7 April 1917.** "Proposed Spillway for Royal Reservoir", Royal Works, W. J. Rainey, Uniontown, dated July 1919.**
As-Built Drawings	None available.
Regional Vicinity Map	U.S.G.S. 7-1/2 Minute New Salem, Pennsylvania Quadrangle Map.**
*Construction History	Built in 1907-1908 by W. J. Rainey Company. Principal Spillway (24 terra cotta pipes) added in 1914, Emergency Spillway added 1919-1920.
*Typical Sections of Dam	See Design Drawings above.
*Outlets-Plan Details Constraints Discharge Ratings	Original dam had 6 inch cast iron water supply pipe and two 16 inch terra cotta drain pipes. All pipes had gate valve controls. Two 24 terra cotta overflow drain pipes, added in 1914.

ITEM	REMARKS
*Rainfall/Reservoir Records	Dam overtopped 19 feet of crest length 22 March 1916 (no depth recorded). Storm of 3 August 1935 with dam empty and blowoff open water rose to within 7 feet of spillway crest.
Geology Reports	None available.
Design Computations	None available.
*Hydrology and Hydraulics	Calculations on Principal Spillway Capacity (two 24 inch terra cotta pipes) dated 11-10-14. Report in 1 June 1924 dam inspection report that maximum depth of flow in spillway was one foot.
Dam Stability	None available.
Seepage Studies	None available.
Materials Investigations, Boring Records, Laboratory, Field	None available.
*Post-Construction Surveys of Dam	See "Report Upon the Royal Dam of W. J. Rainey" prepared for the Water Supply Commission and dated 12 November 1914. See also "Supplemental Report Upon the Royal Dam of W. J. Rainey", prepared for the Water Supply Commission, dated 12 August 1916.
*Borrow Sources	Material excavated from mineshaft across the valley.

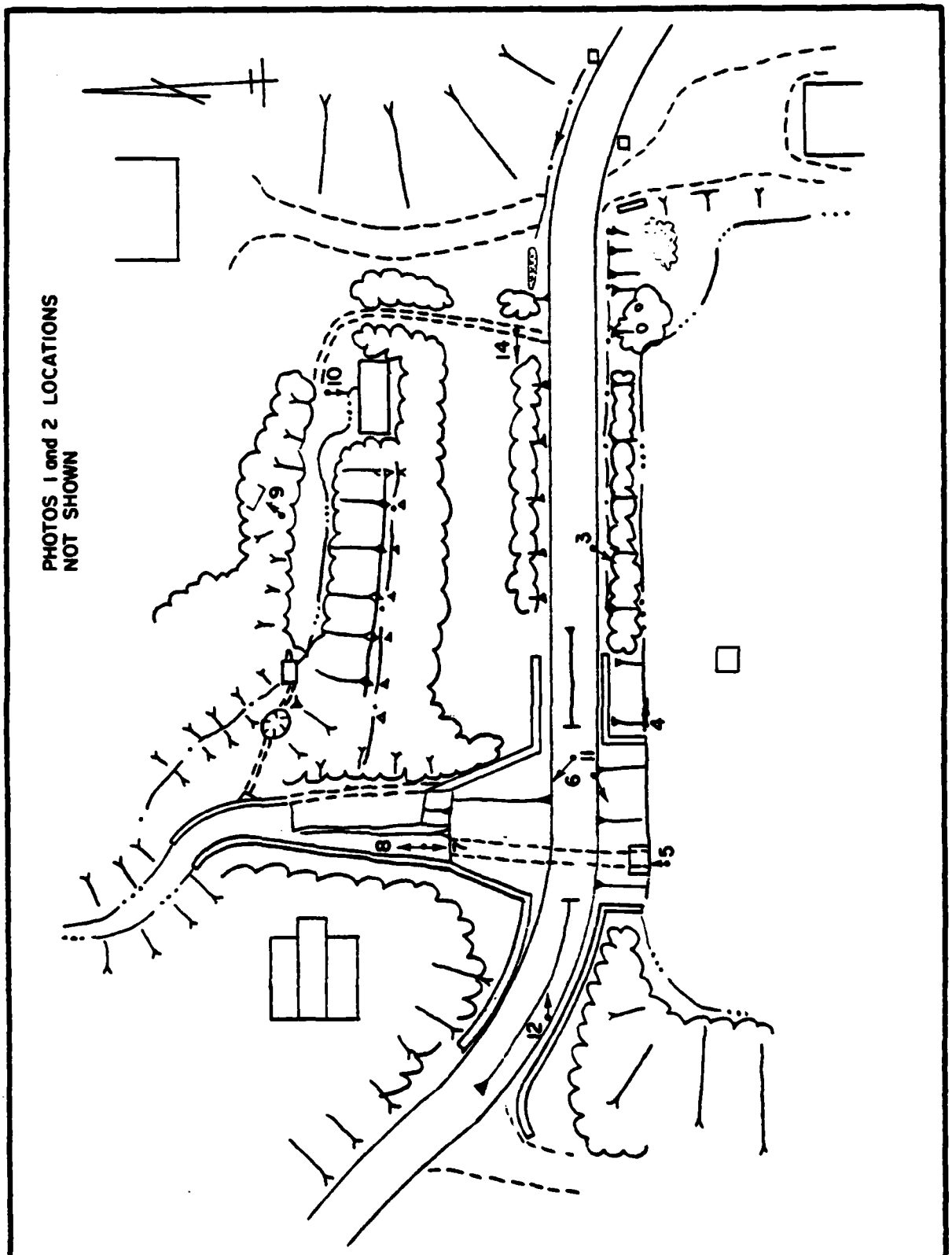
ITEM	REMARKS
Monitoring Systems	None reported.
*Modifications	Spillway added in 1919-1920 upon order of Water Supply Commission to provide spillway capacity of at least 800 cfs with one foot of freeboard. See "Outlets - . . ." above.
*High Pool Records	See Rainfall/Resevoir Records above.
Post-Construction Engineering Studies and Reports	None available.
Maintenance, Operation, Records	None available.
*Spillway Plan Sections Details	See Design Drawings above and "Report Upon the Plans of W.J. Rainey for alterations to Royal Dam" prepared for the Water Supply Commission, dated 30 July 1919.
Operating Equipment Plans and Details	None available.
Specifications	None available.
*Miscellaneous	Seven inspection reports by Water Resources Board Personnel and related correspondence through 11 August 1961. One inspection report on dam by owner, dated 1 June 1924. Correspondence to Water and Power Resources Board from Frank Kropie Jr. requesting permission to close outlet works valve and fill reservoir, dated 24 January 1952.

ITEM	REMARKS
*Prior Accidents or Failure of Dam Description Reports	Dam overtopped 22 March 1916. No depth recorded.

*Information and data may be obtained from the PennDER, Harrisburg, Pennsylvania.
**Reduced size reproductions contained in Appendix E.

APPENDIX C

PHOTOGRAPHS



DATE: JULY 1980		ROYAL RESERVOIR DAM NATIONAL DAM INSPECTION PROGRAM	PHOTO KEY MAP
SCALE: NONE			
DR: JF	CK:	A. C. ACKENHEIL & ASSOCIATES, INC. CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.	
DWG. NO.			

ROYAL RESERVOIR DAM

PHOTO 1. DIKE

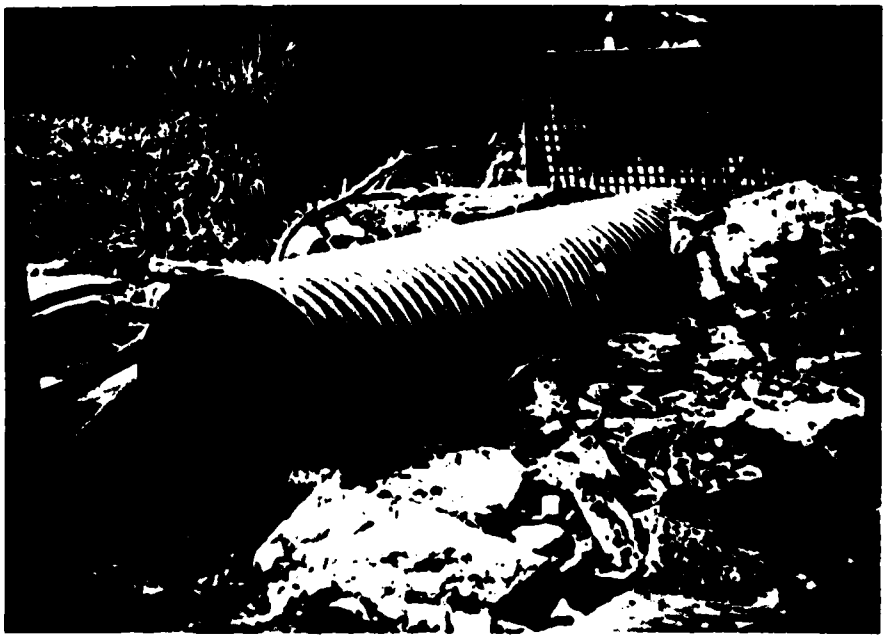


PHOTO 2. DISCHARGE CHANNEL

PHOTO 3. INTAKE STRUCTURE

PHOTO 4. UPSTREAM SLOPE

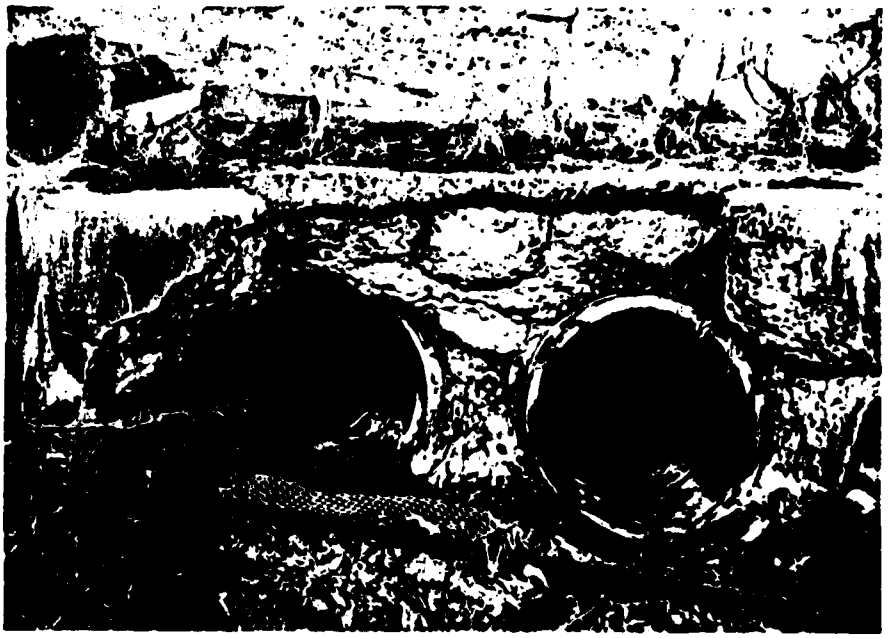


PHOTO 5. PRINCIPAL SPILLWAY INLET

PHOTO 6. EMERGENCY SPILLWAY

PHOTO 7. PRINCIPAL SPILLWAY OUTLET

PHOTO 8. EMERGENCY SPILLWAY

PHOTO 9. MINE PORTAL

PHOTO 10. UNKNOWN BUILDING

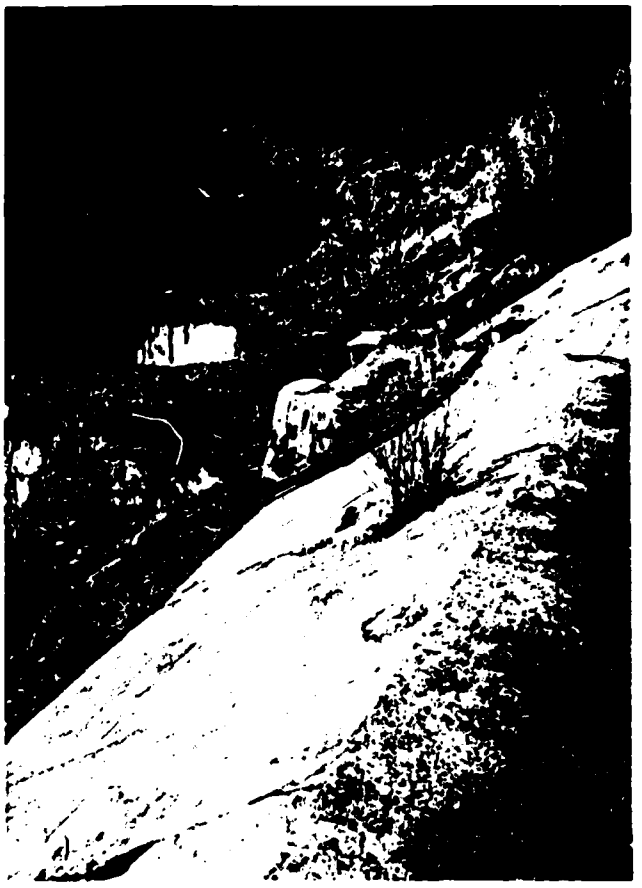


PHOTO 11. PRINCIPAL AND EMERGENCY SPILLWAY INLETS

PHOTO 12. CREST

PHOTO 13. DOWNSTREAM SLOPE

PHOTO 14. DOWNSTREAM SLOPE

PHOTO 13. DOWNSTREAM SLOPE

PHOTO 14. DOWNSTREAM SLOPE

DETAILED PHOTO DESCRIPTIONS

Photo 1 Dike at upper end of lake.

Photo 2 Discharge Channel through isthmus at upper end of lake.

Photo 3 Intake Structure for outlet works. Note lack of surface disturbance.

Photo 4 Upstream Slope as seen from spillway.

Photo 5 Principal Spillway Inlet.

Photo 6 Emergency Spillway discharge channel. Note roadway in foreground.

Photo 7 Principal Spillway Outlet. Note pipe sag and discharge.

Photo 8 Emergency Spillway chute, below principal spillway outlet. Right wall collapsed.

Photo 9 Mine Portal immediately downstream of dam.

Photo 10 Unknown Building at toe of dam.

Photo 11 Principal and Emergency Spillway Inlets.

Photo 12 Crest of dam showing road and emergency spillway.

Photo 13 Downstream Slope near toe.

Photo 14 Downstream Slope showing extensive bench below roadway as seen from right abutment.

APPENDIX D

HYDROLOGY AND HYDRAULICS ANALYSES

APPENDIX D
HYDROLOGY AND HYDRAULICS

Methodology: The dam overtopping analysis was accomplished using the systemized computer program HEC-1 (Dam Safety Version), July, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. A brief description of the methodology used in the analysis is presented below.

1. Precipitation: The Probable Maximum Precipitation (PMP) is derived and determined from regional charts prepared from past rainfall records including "Hydrometeorological Report No. 33" prepared by the U.S. Weather Bureau.

The index rainfall is reduced from 10% to 20% depending on watershed size by utilization of what is termed the HOP Brook adjustment factor. Distribution of the total rainfall is made by the computer program using distribution methods developed by the Corps.

2. Inflow Hydrograph: The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for reservoir routing.

The unit hydrograph is developed using the Snyder method. This method requires calculation of several key parameters. The following list gives these parameters, their definition and how they were obtained for these analyses.

Parameter	Definition	Where Obtained
Ct	Coefficient representing variations of watershed	From Corps of Engineers*
L	Length of main stream channel	From U.S.G.S. 7.5 minute topographic map
Lca	Length on main stream to centroid of watershed	From U.S.G.S. 7.5 minute topographic map

Cp	Peaking coefficient	From Corps of Engineers*
A	Watershed size	From U.S.G.S. 7.5 minute topographic map

3. Routing: Reservoir routing is accomplished by using Modified Puls routing techniques where the flood hydrograph is routed through reservoir storage. Hydraulic capacities of the outlet works, spillways and the crest of the dam are used as outlet controls in the routing.

The hydraulic capacity of the outlet works can either be calculated and input or sufficient dimensions input and the program will calculate an elevation-discharge relationship.

Storage in the pool area is defined by an area-elevation relationship from which the computer calculates storage. Surface areas are either planimetered from available mapping or U.S.G.S. 7.5 minute series topographic maps or taken from reasonably accurate design data.

4. Dam Overtopping: Using given percentages of the PMF the computer program will calculate the percentage of the PMF which can be controlled by the reservoir and spillway without the dam overtopping.

*Developed by the Corps of Engineers on a regional basis for Pennsylvania.

HYDROLOGIC AND HYDRAULIC ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Predominately woodland and pasture.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1003.7 (82 acre-feet.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1013.6 (239 acre-feet.)

ELEVATION MAXIMUM DESIGN POOL: 1013.6

ELEVATION TOP DAM: 1013.6 (minimum)

OVERFLOW SECTION

a. Elevation 1010.8 (average)
b. Type Concrete open channel
c. Width 30 feet
d. Length 59 feet
e. Location Spillover Left of centerline
f. Number and Type of Gates None

OUTLET WORKS

a. Type 6 inch outlet pipe (water supply pipe)
b. Location Unknown
c. Entrance Inverts Unknown
d. Exit Inverts Unknown
e. Emergency Drawdown Facilities Unknown

HYDROMETEOROLOGICAL GAGES

a. Type None
b. Location N/A
c. Records None

MAXIMUM REPORTED NON-DAMAGING DISCHARGE Overtopped 22 March 1916. No depth of overtopping reported. Structure did not fail.

HEC-1 DAM SAFETY VERSION
HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: Royal Reservoir Dam	NDI ID NO. PA 220
Probable Maximum Precipitation (PMP)	24.2*
Drainage Area	1.6 sq. mi.
Reduction of PMP Rainfall for Data Fit Reduce by 20%, therefore PMP rainfall =	0.8 (24.2) =19.4 in.
Adjustments of PMF for Drainage Area (Zone 7)	
6 hrs.	102%
12 hrs.	120%
24 hrs.	130%
Snyder Unit Hydrograph Parameters	
Zone	29**
C_p	0.5
C_t	1.6
L	1.52 mile
L_{ca}	0.57 mile
$t_p = C_t (L \cdot L_{ca})^{0.3}$ =	1.53 hours
Loss Rates	
Initial Loss	1.0 inch
Constant Loss Rate	0.05 inch/hour
Base Flow Generation Parameters	
Flow at Start of Storm	1.5 cfs/sq.mi=2.4 cfs
Base Flow Cutoff	0.05 x Q peak
Recession Ratio	2.0
Overflow Section Data	
Crest Length	59 feet
Freeboard Above Crest	3.1 feet
Discharge Coefficient	2.62
Exponent	1.5
Discharge Capacity	724 cfs

---

* Hydrometerological Report 33
** Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients (C_p and C_t).

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PITTSBURGH, PA 15216
(412) 531-7111

Sheet _____ of _____

Job Royal Reservoir Dam Job No. 79153K

Subject Data Input

Made By JPH Date 6/7/80 Checked SGM Date 6/30/80

Loss Rate and Base Flow Parameters

As recommended by Corps of Engineers, Baltimore District

STRTL = 1 inch
CNSTL = 0.05 inches/hour
STRTQ = 1.5 cfs/mi²
QRCSN = 0.05 (5% of Peak Flow)
RTIOR = 2.0

Elevation-Area-Capacity Relationships

From U.S.G.S. 7.5 min Quad, Penndot Files and Field Inspection Data.

At Principal Spillway Invert elevation 1003.7

Initial Storage 82 Acre Feet

Pond Surface Area 8 ACRES

AT elevation 1020 Area = 28 ACRES

AT elevation 1040 Area = 83 acres

From Conic Method of Reservoir Volume
Flood Hydrograph Package (HEC-1)
Dam Safety Version (Users' Manual)

$H = 3V/A$ $H = 3(82)/8 = 30.8$

Elevation Where Area Equals Zero

$1003.7 - 30.8 = 972.9$

AREA	$A	0.0	8.0	28.0	83.0
ELEVATION	$E	972.9	1003.7	1020.0	1040.0

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(412) 531-7111

Sheet _____ of _____

Job Royal Reservoir Dam Job No. 79153K

Subject Data Input

Made By JPH Date 6/9/80 Checked SOM Date 6/30/80

Dam Overtop Parameters

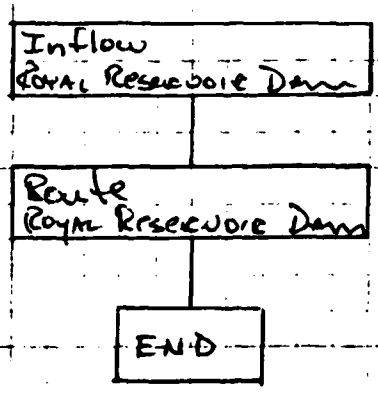
Top of Dam Elevation (Lowpoint)	1013.6
Length of Dam (Excluding Spillway)	400 feet
Coefficient of Discharge "C"	3.09

EL_{max} 410. EV_{max} 1017.

Emergency Spillway Parameters

Spillway Crest Elevation	1010.8
Length of Spillway Crest	59 feet
Coefficient of Discharge "C"	2.62

Program Schedule



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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
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```
    1              A1       NATIONAL PROGRAM FOR THE INSPECTION OF NON FEDERAL DAMS
    2              A2       HYDROLOGIC AND HYDRAULIC ANALYSIS OF ROYAL RESERVOIR DAM
    3              A3       PROBABLE MAXIMUM FLOOD PMF/UNIT HYDROGRAPH BY SNYDER'S METHOD
    4              B   100       0      15       0       0       0       0       0      -4       0
    5              B1    5
    6              J     1       3       1
    7              J1   1.      .5      .2
    8              K     0       1                                               1
    9              K1       INFLOW HYDROGRAPH FOR ROYAL RESERVOIR DAM
   10              M     1       1     1.6               1.6       1                              .1
   11              P            19.4     102     120     130
   12              T                                                       1.0     .05
   13              W  1.53     0.5
   14              X  -1.5   -0.05     2.0
   15              K     1       2                                               1
   16              K1       ROUTING AT ROYAL RESERVOIR DAM
   17              Y                                       1       1
   18              Y1    1                                                 82.
   19              $A    0.      8.     19.     28.     83.
   20              $E 972.9  1003.7   1010.   1020.   1040.
   21              $B1010.8    59.    2.62     1.5
   22              $D1013.6    3.09     1.5    400.
   23              $L   20.     40.    280.    360.    410.
   24              $V1013.6  1014.    1015.   1016.   1017.
   25              K    99
   26              A
   27              A
   28              A
   29              A
   30              A
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT 1
ROUTE HYDROGRAPH TO 2
END OF NETWORK

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
```

RUN DATE: 11 JUN 80
RUN TIME: 13.12.42

NATIONAL PROGRAM FOR THE INSPECTION OF NON FEDERAL DAMS
HYDROLOGIC AND HYDRAULIC ANALYSIS OF ROYAL RESERVOIR DAM
PROBABLE MAXIMUM FLOOD PMF/UNIT HYDROGRAPH BY SNYDER'S METHOD

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 3 LRTIO= 1
RTIOS= 1.00 0.50 0.20

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH FOR ROYAL RESERVOIR DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.60	0.0	1.60	1.00	0.0	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	19.40	102.00	120.00	130.00	0.0	0.0	0.0

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.0	0.0	1.00	0.0	0.0	1.00	1.00	0.05	0.0	0.0

UNIT HYDROGRAPH DATA

TP= 1.53 CP=0.50 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH 48 END-OF-PERIOD ORDINATES, LAG= 1.54 HOURS, CP= 0.50 VOL
= 1.00

19.	71.	143.	222.	290.	332.	338.	311.	276.	244.
216.	191.	169.	150.	133.	117.	104.	92.	81.	72.
64.	57.	50.	44.	39.	35.	31.	27.	24.	21.
19.	17.	15.	13.	12.	10.	9.	8.	7.	6.
6.	5.	4.	4.	3.	3.	3.	2.		

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

SUM 25.22 23.34 1.88 94061.
(641.)(593.)(48.)(2663.52)

****

HYDROGRAPH ROUTING

ROUTING AT ROYAL RESERVOIR DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.0	0.0	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.0	0.0	0.0	82.	0

SURFACE AREA=	0.	8.	19.	28.	83.
CAPACITY=	0.	82.	165.	398.	1460.
ELEVATION=	973.	1004.	1010.	1020.	1040.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1010.8	59.0	2.6	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1013.6	3.1	1.5	400.

CREST LENGTH AT OR BELOW ELEVATION	20.	40.	280.	360.	410.
	1013.6	1014.0	1015.0	1016.0	1017.0

PEAK OUTFLOW IS 4011. AT TIME 17.25 HOURS

PEAK OUTFLOW IS 1991. AT TIME 17.50 HOURS

PEAK OUTFLOW IS 703. AT TIME 18.25 HOURS

****

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 0.50	RATIO 3 0.20
HYDROGRAPH AT	1	1.60	1	4036.	2018.	807.
	(	4.14)	(	114.29)(	57.15)(	22.86)(
ROUTED TO	2	1.60	1	4011.	1991.	703.
	(	4.14)	(	113.59)(	56.38)(	19.90)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1003.65	1010.80	1013.60
STORAGE	82.	180.	239.
OUTFLOW	0.	0.	724.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1016.12	2.52	297.	4011.	9.25	17.25	0.0
0.50	1015.14	1.54	273.	1991.	5.75	17.50	0.0
0.20	1013.54	0.0	237.	703.	0.0	18.25	0.0

Sheet _____ of _____

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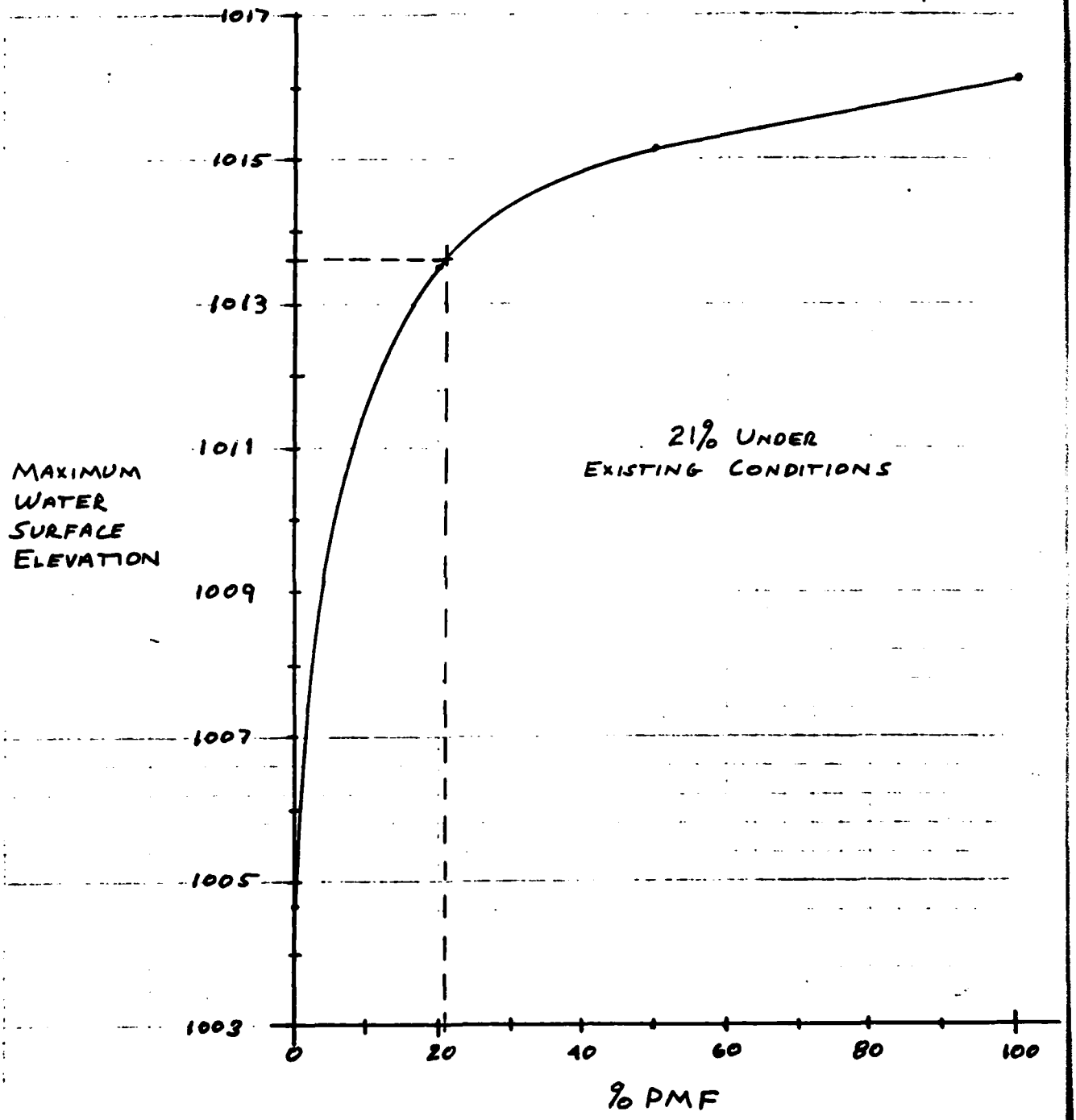
Job ROYAL RESERVOIR DAM Job No. 79153-K

Subject HYDROLOGIC PERFORMANCE PLOT

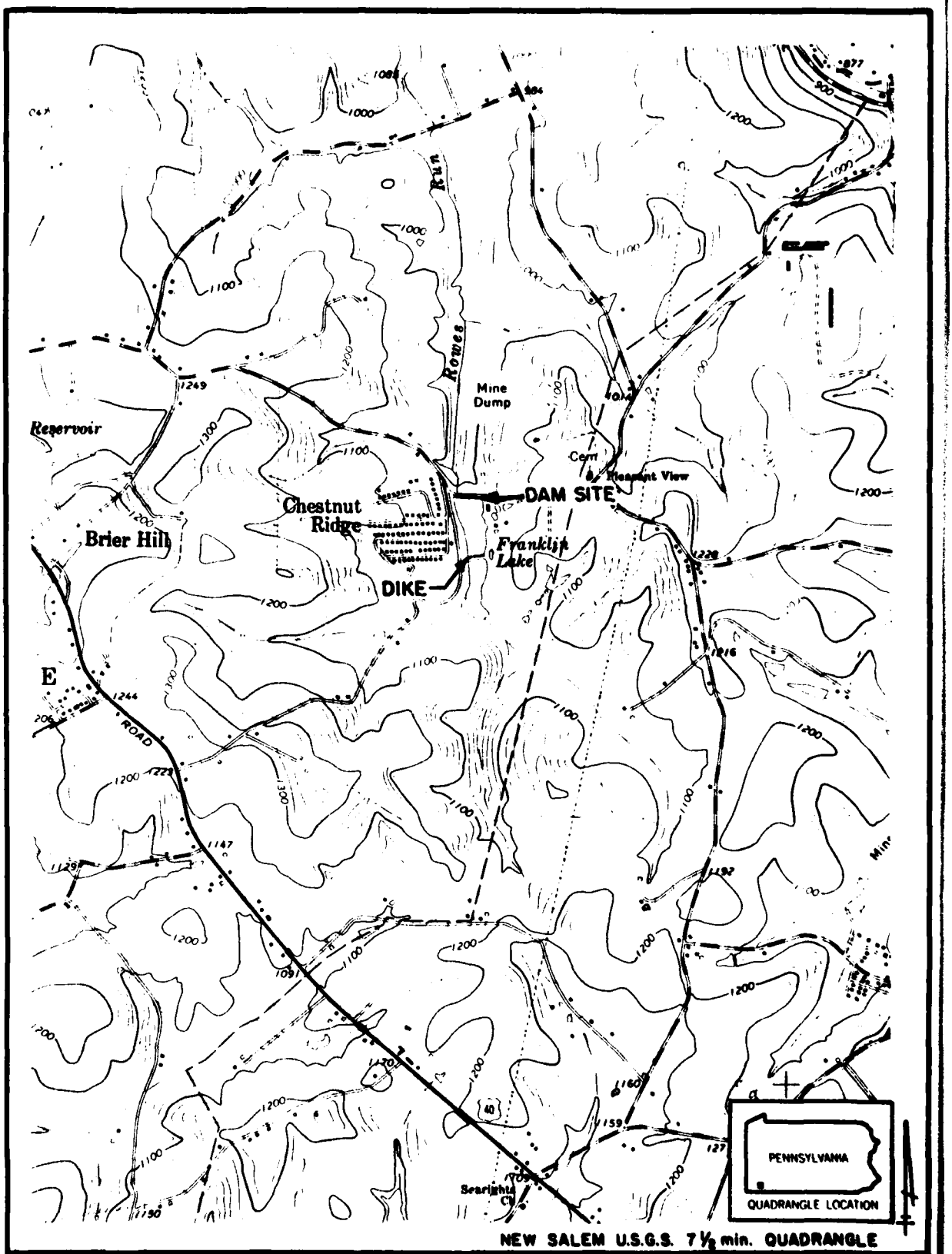
Made By SGM Date 6/26/80 Checked JPH Date 6/30/80



APPENDIX E

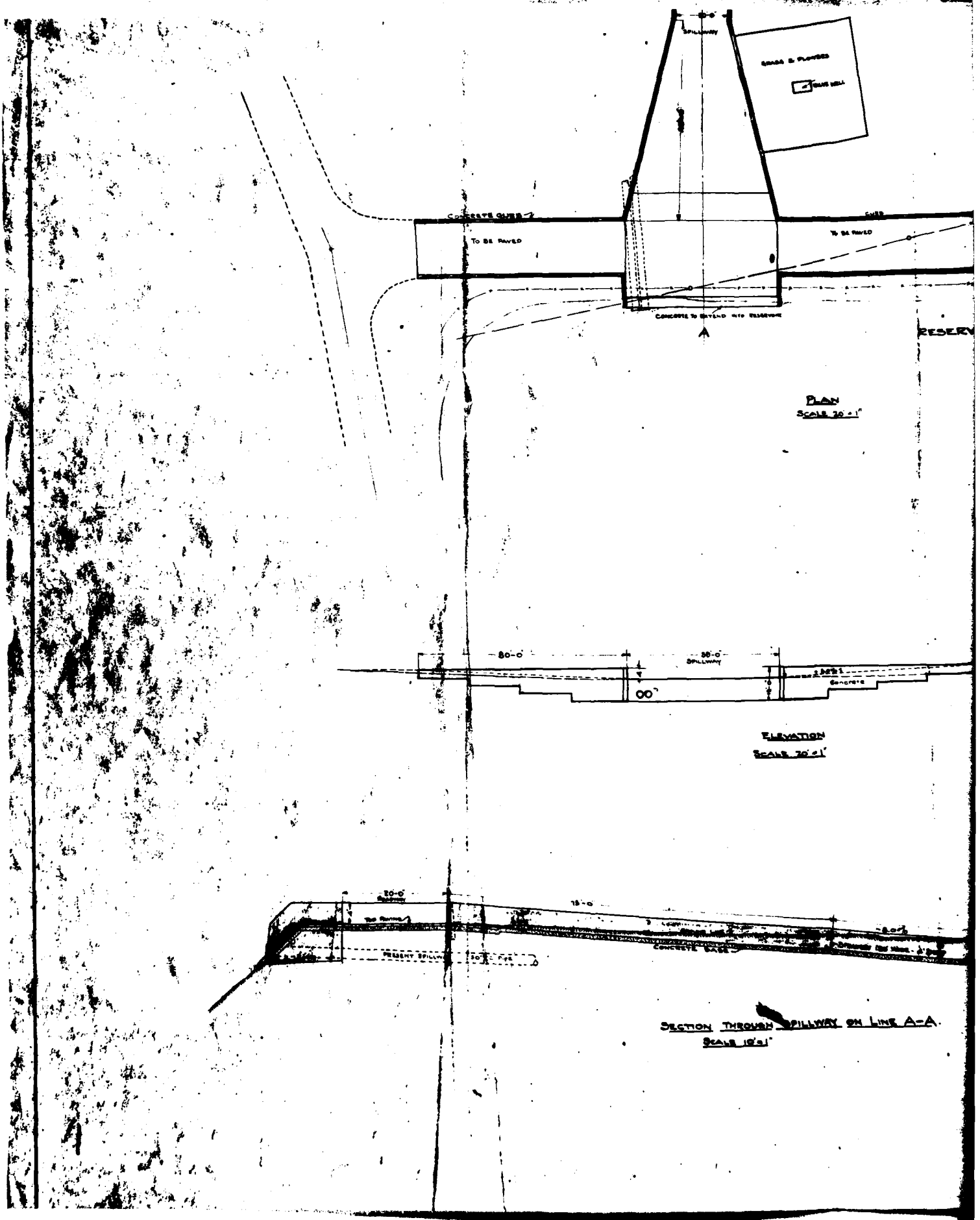
PLATES

LIST OF PLATES



NEW SALEM U.S.G.S. 7½ min. QUADRANGLE

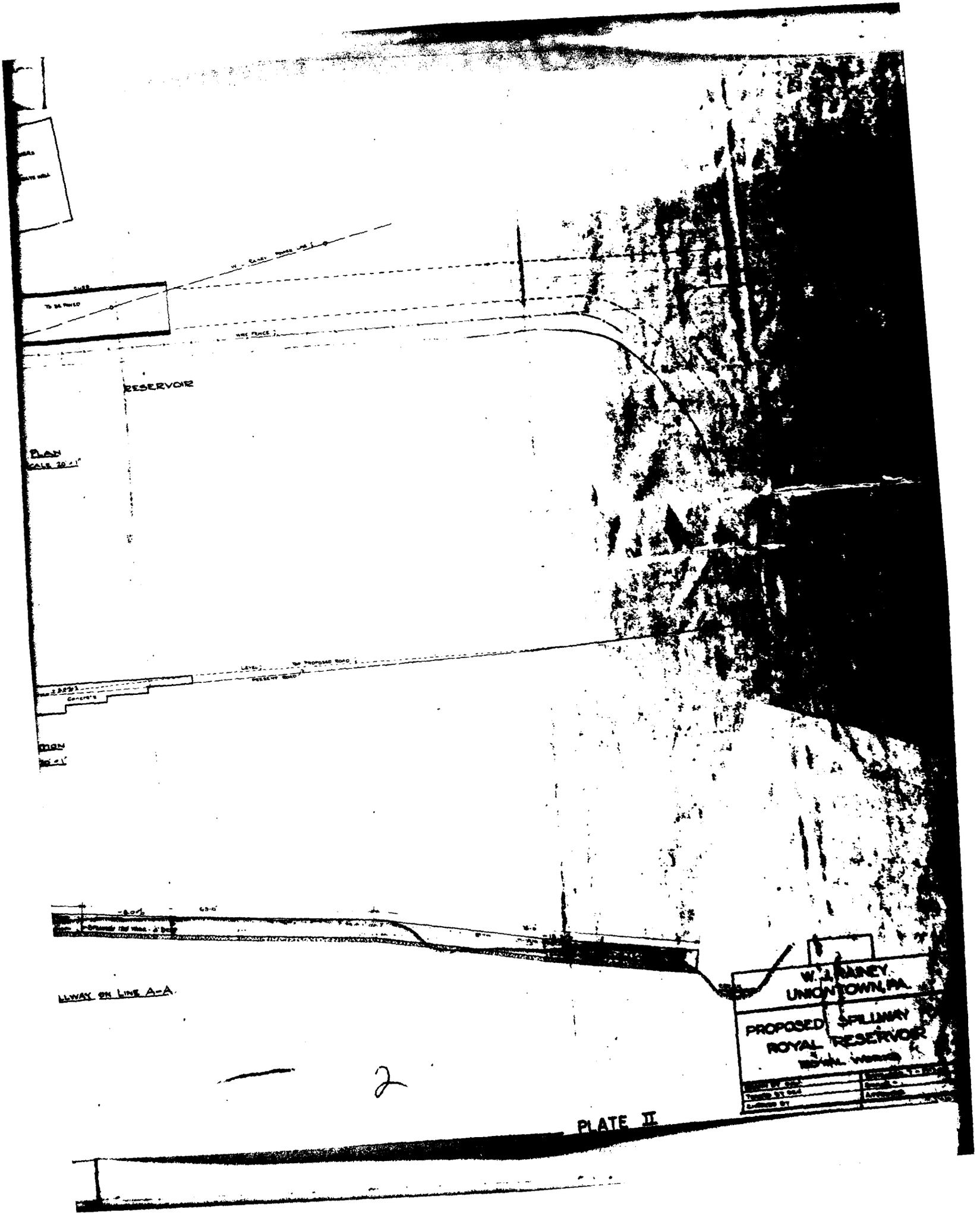
DATE: JULY 1980	ROYAL RESERVOIR DAM NATIONAL DAM INSPECTION PROGRAM	REGIONAL VICINITY MAP
SCALE: 1" = 2000'		
DR: JF CK:	A. C. ACKENHEIL & ASSOCIATES, INC. CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.	
DWG. NO. PLATE I		



PLAN
SCALE 30 = 1"

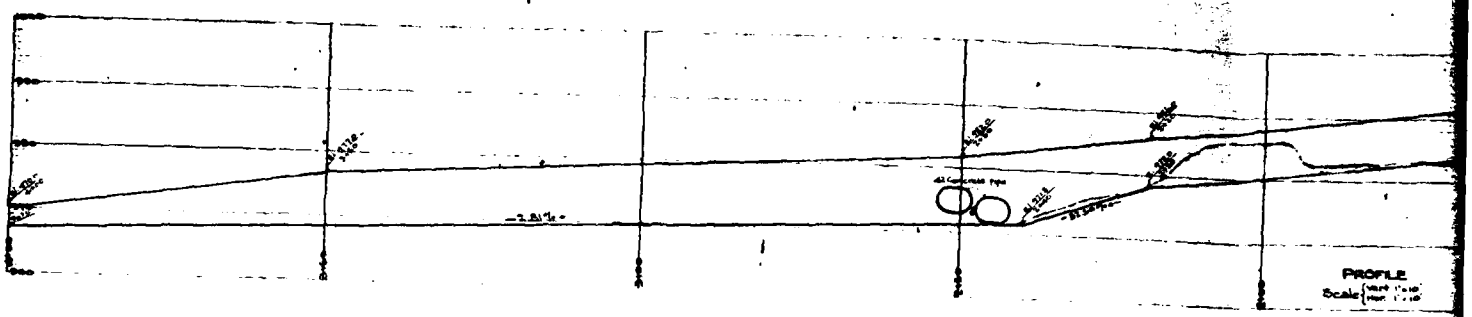
ELEVATION
SCALE 30 = 1"

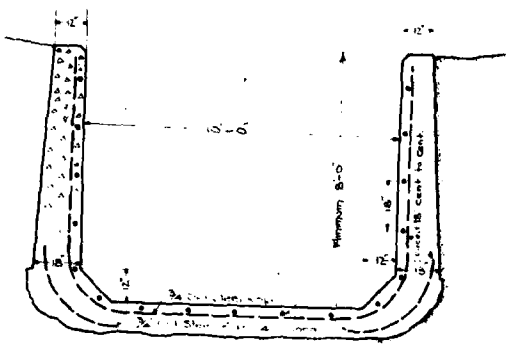
SECTION THROUGH SPILLWAY ON LINE A-A
SCALE 10 = 1"


RESERVOIR
PLAN
SCALE 20-1"
PROPOSED ROAD
PRESENT ROAD
Concrete
LLWAY ON LINE A-A
W. J. RANEY
UNIONTOWN, PA.
PROPOSED SPILLWAY
ROYAL RESERVOIR

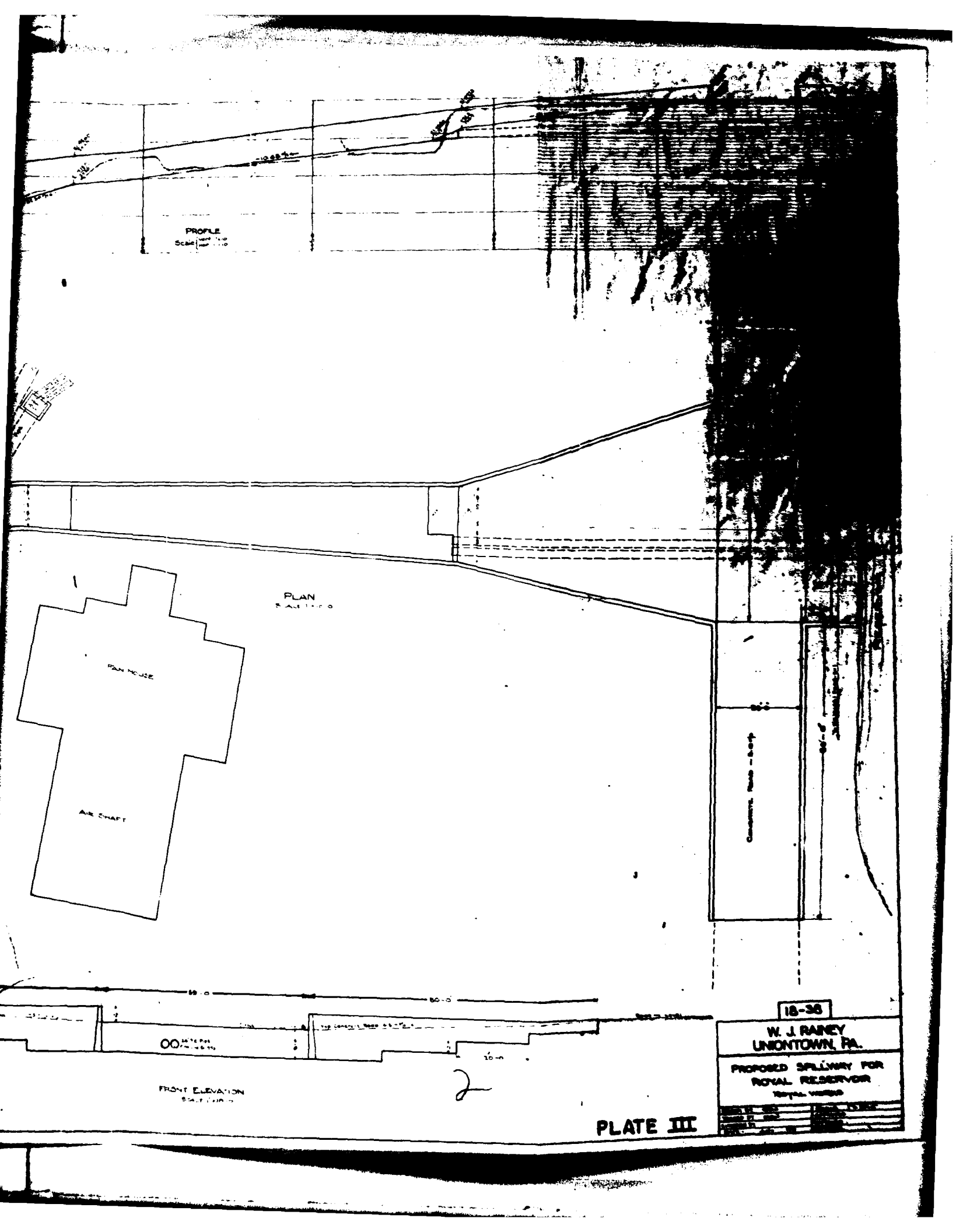
2

PLATE II





SECTION ON LINE A - A
Scale 3/4"=1'-0


PROFILE
PLAN
FAN HOUSE
AIR SHAFT
FRONT ELEVATION
18-38
W. J. RAINEY
UNIONTOWN, PA.
PROPOSED SPILLWAY FOR
ROYAL RESERVOIR
PLATE III

APPENDIX F

GEOLOGY

GEOLOGY

Geomorphology

The bedrock in the area of Royal Reservoir Dam is part of the Pittsburgh Plateau section of the Appalachian Plateau Physiographic Province. This area is characterized by essentially flat lying sedimentary rocks which have been deeply cut by streams in many places to form steep sided valleys. Royal Reservoir Dam is located along Rowes Run, a tributary of Redstone Creek. The rounded hilltops near the dam are at Elevation 1200 to 1300 feet and in a regional sense are part of a broad undulating plateau. The valley bottom near the dam is at about Elevation 1000 feet.

Structure

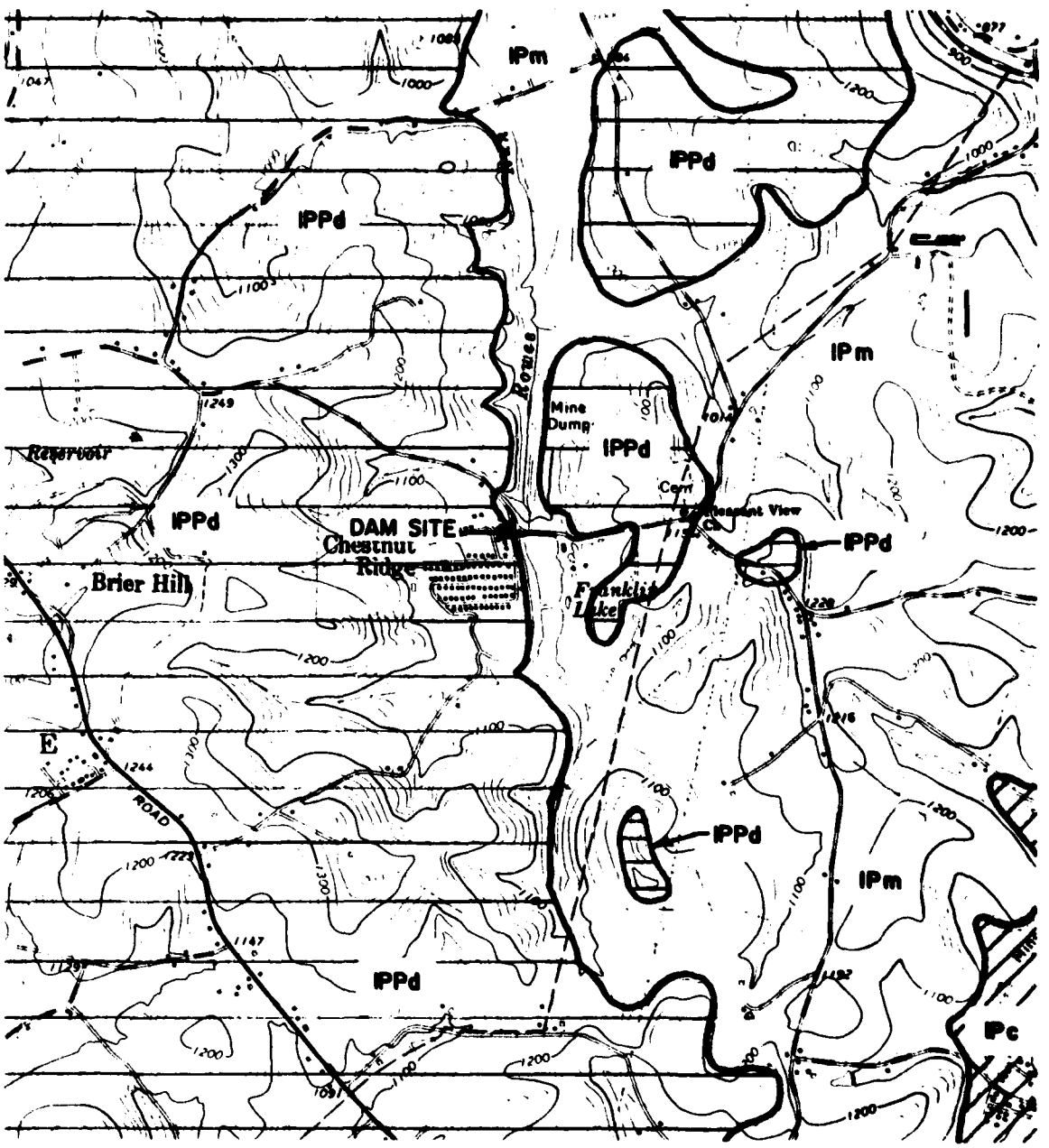
Regionally, the dam lies on the east flank of the Lambert syncline about 1 mile east of its axis. The dip of the bedrock strata is 278 feet/mile (3°) to the west.

Stratigraphy

General: The Royal Reservoir Dam is located along the stratigraphic boundary of the Monongahela Group of Pennsylvanian Age and the Dunkard Group of Permian Age. The Waynesburg Coal Seam which marks the stratagraphic boundry between these two groups immediately adjacent to the dam site at Elevation 1020 feet. The Royal Reservoir Dam and its lake are at about Elevation 1010 feet.

Mining Activity: Based on field observations and W.P.A. mine maps, no indications were observed that the Waynesburg Coal Seam adjacent to the dam site has been mined. The Pittsburgh Coal Seam located at about 200 feet below the dam has been extensively deep mined.

Rock Types: The dam is located over rocks that consist primarily of sandstone.



NEW SALEM QUADRANGLE, FAYETTE COUNTY, PENNSYLVANIA

SCALE: 0 1/2 MILE 1:24000

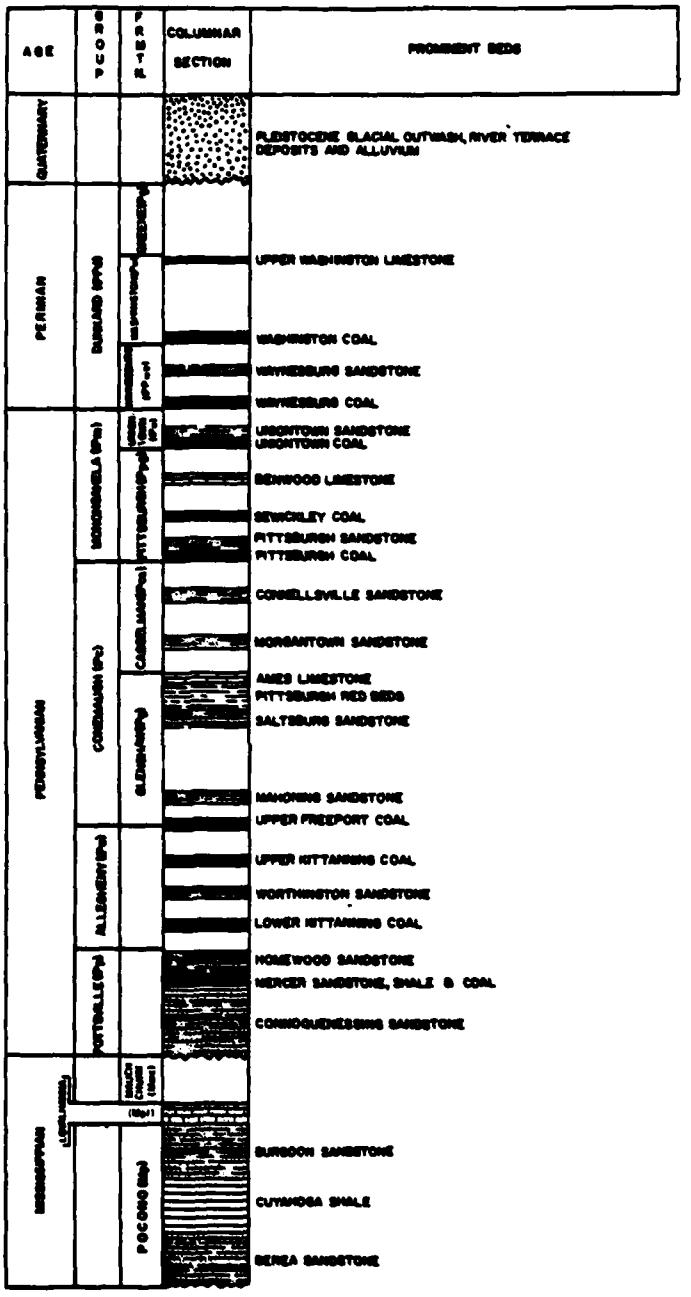
CONTOUR INTERVAL 20 FT. DATUM IS MEAN SEA LEVEL

FORMATION CONTACT

DATA OBTAINED FROM PENNSYLVANIA TOPOGRAPHIC AND GEOLOGIC SURVEY, GEOLOGIC MAP OF FAYETTE COUNTY, PENNSYLVANIA, 1940 and COAL AND SURFACE STRUCTURE MAP OF FAYETTE COUNTY, PENNSYLVANIA, 1940

DATE: JULY 1980		ROYAL RESERVOIR DAM NATIONAL DAM INSPECTION PROGRAM	GEOLOGIC MAP
SCALE: 1" = 2000'			
DR: JF	CK:	A. C. ACKENHEIL & ASSOCIATES, INC. CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.	

10 7100 ALBANENE A. B. SMITH CO., PGH., PA.



DATE: JULY 1980	ROYAL RESERVOIR DAM NATIONAL DAM INSPECTION PROGRAM		GEOLOGIC COLUMN
SCALE: 1" = 360'			
DR: JF	CK:	A. C. ACKENHEIL & ASSOCIATES, INC. CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.	